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TECHNOLOGY POLICY AND ECONOMICS

AN OVERVIEW OF THE VALUE OF PARABOLIC DISH SOLAR THERMAL SYSTEMS IN INDUSTRIAL COGENERATION APPLICATIONS

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1.0 INTRODUCTION AND SUMMARY

1.1 INTRODUCTION

This study was commissioned by the Thermal Power Systems Project of the Jet Propulsion Laboratory (JPL) to examine the breakeven values of Brayton cycle parabolic dish solar thermal electric systems in cogeneration applications. The essential elements of the cogeneration system configuration to be captured were the displacement of thermal energy by collection and use of the Brayton exhaust stream, and the sale back to the utility of any electricity production in excess of on-site requirements. In contrast to simply "dumping" these energy flows, their use or sale obviously serves, by itself, to increase gross value of the solar thermal energy system. Net allowable cost of the parabolic dish modules may or may not be increased, however. The first consideration is that the waste heat capture and delivery subsystems are not free. This study does not address the incremental cost of adding waste heat capture, transport, and conversion (to steam, if necessary). It does compute a value for the thermal energy thereby displaced. This value can serve as a first-round input to any detailed economic evaluation of waste heat recovery.

The second consideration involves the relatively high discount rates appropriate to industrial ownership cases. While the cogeneration provisions of Section 210 of the Public Utilities Regulatory Policies Act of 1978 (PURPA) would appear to offer favorable terms for industry sell-back (to the utility) of excess cogenerated power, the relatively stringent (compared to utilities) requirements for return on investment for industrially-owned systems may offset any such advantages. An interesting question, beyond the scope of this study, involves the advantages of some tax-structured ownership form to reduce the cost of capital, and leave more of the energy displacement benefits intact after discounting.

The basic intent of this study is to provide a general set of allowable cost numbers, based on realistic values for system performance,

energy prices and industry economic parameters. These allowable costs can be taken as indicative of the range of system values to be encountered in cogeneration applications under the assumptions used. As in any such study, substantial deviations from these assumptions, particularly with respect to first-order influences such as energy price escalation rates, discount rates, system performances, or system O&M costs, can change these results dramatically.

1.2 SUMMARY

Table 1.1 displays the range of allowable installed system costs found in the analysis. Notice a roughly 2:1 variation in allowable cost in each case as the discount rate is varied from 15 percent to 25 percent. (10 percent is an unrealistically low discount rate, given the assumptions used for general inflation. It is presented purely for illustrative purposes.) This result, common to studies such as this one, shows the major importance of the capital budgeting criteria used by the potential customer in determining values.

A second interesting characteristic of the results in Table 1.1. is the modest increases in system value per m^2 as system size is increased. Since the importance of power sold back to the utility is directly related to system size (the percentage margin measures the extent to which system output under peak conditions exceeds on-site electric load), this implies a weak effect of utility sell-back on value. Actually, the increase in value is due as much to the effects of larger reductions in peak demand (from the larger systems) on the user's electricity bill as to the value of exported energy.

The programmatic significance of these results must be assessed by comparing them both to the results of similar value analyses for other applications, and to estimates of the ability to supply dish cogeneration systems at such prices. Only then can the determination of whether cogeneration offers an important early market opportunity be made.

The remainder of this report is organized as follows:

Section 2 explains the method of analysis used, and documents the assumptions made on the values of key parameters of the value analysis. Section 3 presents and discusses the results of that analysis (including

Table 1.1. Allowable Installed Cost for Dish Cogeneration System ($\$/m^2$, system)

		APS	SCE
0% Peak Electric Margin			
Discount Rate:	10%	615.24	674.33
	15%	410.69	450.01
	20%	283.79	310.88
	25%	205.38[a]	224.93
10% Peak Electric Margin			
Discount Rate:	10%	630.92	690.99
	15%	421.27	461.25
	20%	291.17	318.72
	25%	210.76	230.65
25% Peak Electric Margin			
Discount Rate:	10%	650.19	718.26[b]
	15%	434.27	479.64
	20%	300.24	331.55
	25%	217.37	240.01

a Minimum value in table

b Maximum value in table

Table 1.1). Appendix A presents the original data on insolation and system performance, as well as the calculations of annual energy displacement. Appendix B contains the documentation of the value calculations, including detailed breakdowns of the sources of system value (i.e., how much of overall system value was contributed by gas displacement, electricity displacement, electricity export, and reduction in demand charges).

2.0 THE METHOD OF ANALYSIS

The overall method of analysis, illustrated in Figure 2.1, shows the progression from input assumptions through the various calculations necessary to determine dish system breakeven values in cogeneration applications. The analysis separates logically into four parts: dish system performance calculations, system sizing assumptions and site-specific performance adjustments, energy price assumptions, and breakeven analysis. Each part will be discussed in this section.

2.1 DISH SYSTEM PERFORMANCE

Time-dependent measures of gross power, both thermal and electric, were found for the reference dish system by combining JPL-supplied information on system performance as a function of insolation levels with a highly-reduced data base on Barstow insolation.

2.1.1 Solar Insolation Data

The basic solar insolation data used for this study was 1976 Barstow (CA) direct insolation. The original data source was monthly computer plots of a WEST Associates data tape used by both JPL and the Solar Energy Research Institute (SERI) in their 1978 comparative ranking studies under the DOE Small Power Systems Program. The computer plots were generated by SERI, and present average direct normal insolation values on 15-minute increments for each month of 1976. Figure 2.2 shows the plot for December, and the process by which hourly insolation ordinates were "picked off" the graph for this study.

Table 2.1 contains the December direct normal insolation ordinates, plus similarly derived data for January and February. These data were averaged to produce the Seasonal Average Insolation figures used for the Winter season. The final column of Table 2.1 displays the area underneath the segments of a curve generated by connecting the average ordinates of the previous column with straight lines. The total of these areas represents the total energy contained in direct normal insolation for a typical day in the January, February, and December portion of 1976. Multiplying this typical day

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FLOW CHART OF ANALYSIS USED TO PRODUCE AREA-SPECIFIC MEASURES OF DISH SYSTEM VALUE PER M² IN COGENERATION APPLICATIONS

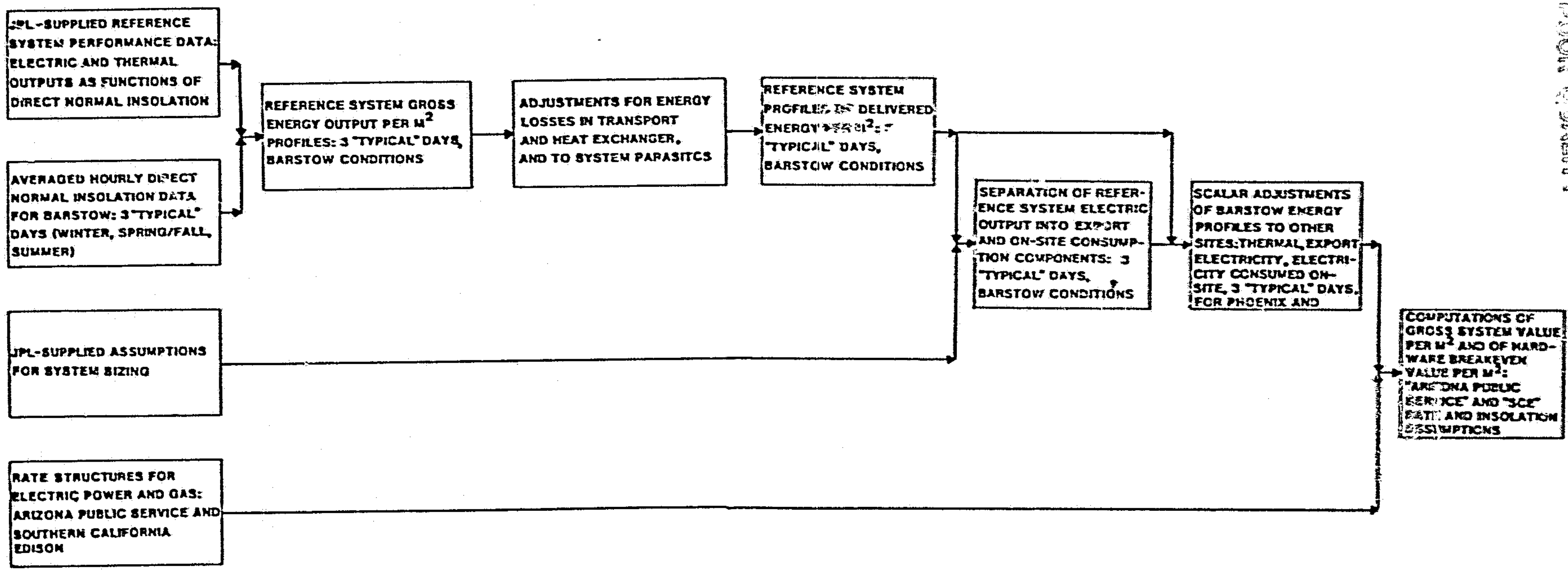

Figure 2.1. Method Flow Chart

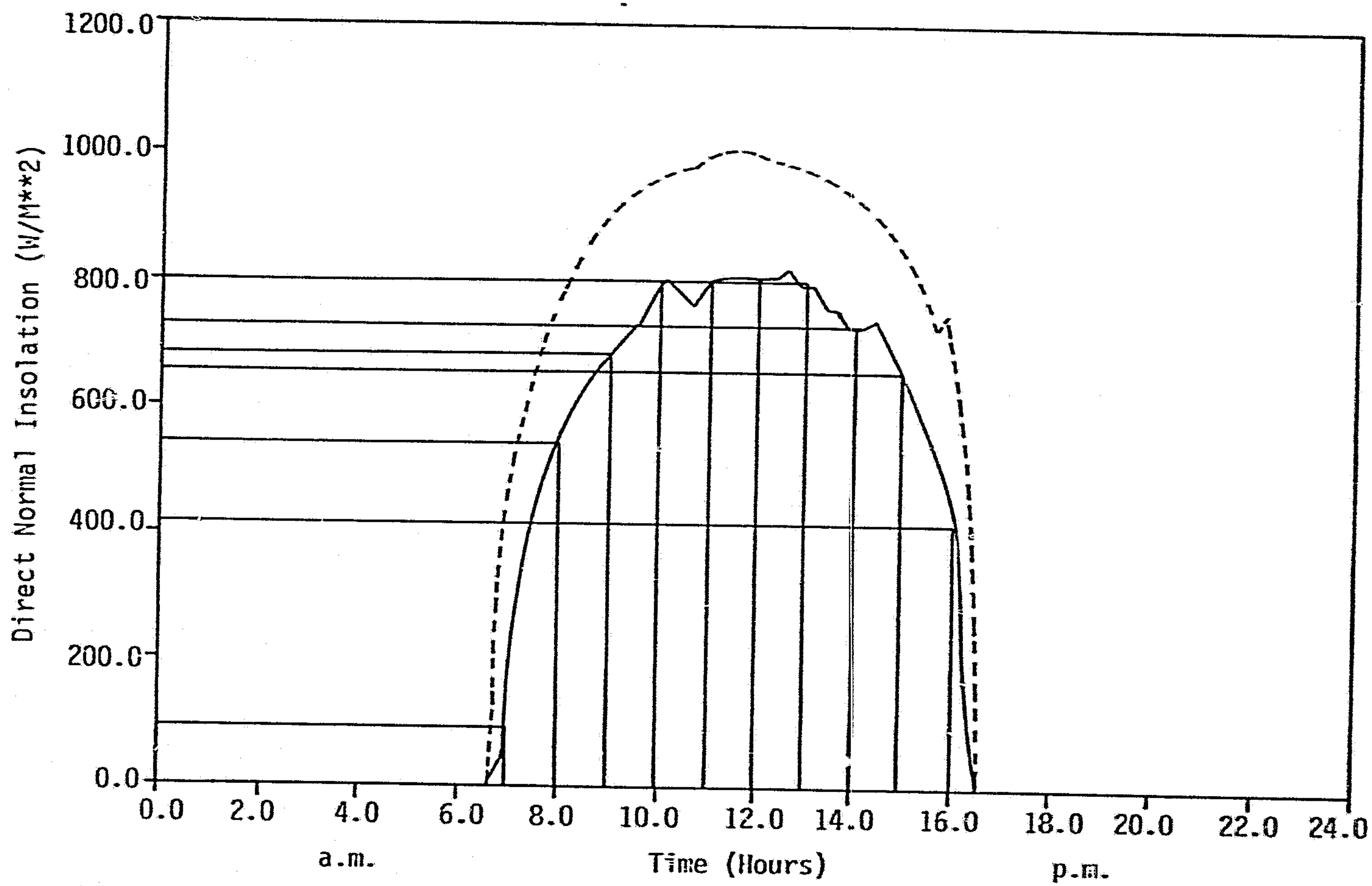

Figure 2.2. Average Barstow December Insolation

Table 2.1

Baseline (Barstow) Insolation Profile

Season Winter (Dec, Jan, Feb) (90 days)

Hour	Dec	Jan	Feb				Seasonal Average Insolation	Total Incid Energy kWh_t/m^2
	Direct Normal Insolation in kW/m^2							
0500	0	0	0				0	
								0
0600	0	0	0				0	
								0.045
0700	0.090	0	0.180				0.090	
								0.331
0800	0.545	0.610	0.560				0.572	
								0.642
0900	0.675	0.770	0.690				0.712	
								0.755
1000	0.800	0.850	0.740				0.797	
								0.806
1100	0.800	0.890	0.755				0.815	
								0.809
1200	0.810	0.875	0.725				0.803	
								0.787
1300	0.790	0.860	0.660				0.770	
								0.739
1400	0.730	0.835	0.560				0.708	
								0.663
1500	0.605	0.725	0.520				0.617	
								0.534
1600	0.420	0.510	0.420				0.450	
								0.263
1700	0	0.025	0.200				0.075	
								0.038
1800	0	0	0				0	
								$\sum$=6.409
								x 90 = 576

total by the number of days in the period (90), produces the estimate of the total direct insolation energy for the entire three-month period. Accordingly, Table 2.1 shows that, on a typical Barstow day in the January, February, and December period, 6.409 kWh_t of direct normal insolation was incident on a square meter of tracking surface area. For the entire three-month period, the total was 576.8 kWh_t.

The rest of the year was divided into two additional seasons. The months March through May, and September through November were averaged into a typical "Spring/Fall" day. June through August were averaged into a typical "Summer" day. Tables for both seasons are given in Appendix A.

2.1.2 System Performance Data

Energy output data for the circa 1985 dish/Brayton system was provided by JPL, in the form of Table 2.2. The table displays calculated values for thermal and electric power levels at evenly-spaced, direct normal insolation levels from 0.125 to 1.025 kW_t/m^2. These insolation-dependent power levels can be used to produce thermal and electric output profiles by combining them with the Barstow insolation profiles discussed in the previous section. This process is shown in Table 2.3 for the Winter season. The first column of Table 2.3 simply repeats the Seasonal Average Insolation data of Table 2.1. The two power level columns are derived by interpolation from the performance data of Table 2.2. (It was assumed, for purposes of this study, that all collected thermal energy was obtained from the Brayton engine exhaust. For flux levels so low that the JPL performance figures show no electricity produced, the thermal power level was also assigned a zero value.) Total energy production in each category is derived as the area underneath the appropriate power level curves, in the same manner used to compute Total Incident Energy in Table 2.1. Table 2.3 indicates that, on a typical Barstow day in the winter season, the reference design dish/Brayton system would produce 3.040 gross kWh_t/m^2, and 1.696 gross kWh_e/m^2. For the entire 90-day January, February, and December period, the corresponding totals are 273.6 kWh_t/m^2, and 152.6 kWh_e/m^2, respectively. Similar calculations were performed to arrive at performance profiles for the Spring/Fall and Summer seasons. They are shown in Appendix A.

TABLE 2.2

PARABOLOIDAL DISH/BRAYTON PERFORMANCE RESULTS

(1985 technology)

(data provided by JPL)

Direct Normal Insolation kW_t/m^2	Waste Heat (Gross Thermal Energy) kW_t/m^2	Electric Power kW_e/m^2
0.125	0.0387	0
0.175	0.0865	0
0.225	0.1050	0.0263
0.275	0.1203	0.0528
0.325	0.1425	0.0706
0.375	0.1689	0.0836
0.425	0.1971	0.0952
0.475	0.2246	0.1090
0.525	0.2499	0.1269
0.575	0.2728	0.1487
0.625	0.2954	0.1715
0.675	0.3205	0.1916
0.725	0.3498	0.2063
0.775	0.3822	0.2161
0.825	0.4148	0.2233
0.875	0.4452	0.2311
0.925	0.4716	0.2429
0.975	0.4929	0.2616
1.025	0.5123	0.2865

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TABLE 2.3

JPL COGENERATION STUDY

Baseline (Barstow) Power/Energy Profile

Season Winter (Dec, Jan, Feb) (90 days)

Hour	Seasonal Average Insolation	Thermal Power Level kW_t/m^2	Gross Thermal Energy Produced kWh_t/m^2	Electric Power Level kW_e/m^2	Gross Electric Energy Produced kWh_e/m^2
0500	0	0		0	
			0		0
0600	0	0		0	
			0		0
0700	0.090	0		0	
			0.136		0.074
0800	0.572	0.271		0.147	
			0.307		0.175
0900	0.712	0.342		0.202	
			0.370		0.211
1000	0.797	0.397		0.219	
			0.403		0.221
1100	0.815	0.408		0.222	
			0.404		0.221
1200	0.803	0.400		0.220	
			0.390		0.218
1300	0.770	0.379		0.215	
			0.360		0.208
1400	0.708	0.340		0.201	
			0.316		0.185
1500	0.617	0.292		0.168	
			0.252		0.135
1600	0.450	0.211		0.102	
			0.106		0.051
1700	0.075	0		0	
			0		0
1800	0	0		0	
			0		0
1900	0	0		0	
			0		0
2000	0	0		0	
			$\sum = 3.040$		$\sum = 1.696$
			x90=273.6		x90=152.6

These profiles reflect gross energy outputs, before any deductions for that portion of output thermal energy which cannot be applied to a load, or for parasitic consumption of electricity. Ideally, these undelivered energy amounts could be determined by a detailed examination of the energy use characteristics of each specific application. For purposes of this general study, it was jointly decided by SAI and JPL to use across-the-board adjustments of a 40% loss of thermal energy between gross and delivered energy, and a 10% loss of electricity. The adjusted power profiles and corresponding displaced energy profiles for Barstow conditions, including a conversion of system thermal output to Btu's of natural gas displaced, are shown in Tables 2.4 and 2.5.

2.2 SYSTEM SIZING ASSUMPTIONS AND PERFORMANCE ADJUSTMENT

2.2.1 System Sizing and the Determination of Electricity Exports

Except at very low insolation levels, the reference dish cogeneration system is assumed to produce electric energy and thermal energy in roughly fixed proportions. Gross system value will depend on the sum of the values of gas and electricity displaced plus any revenue credited to electricity export. For purposes of this study, the per unit values of these various energy effects are assumed fixed. What is not fixed, however, is the separation of produced electricity into the portion that serves to reduce on-site consumption of purchased electricity, and the portion that is sold back to the utility. This division is ultimately a function of the size of the system relative to the (assumed constant) on-site electric load.

Figure 2.3 displays the electric power level profile, in kW_e/m^2, for the reference dish system under Barstow summer conditions. (The coordinates for Figure 2.3 are taken from Table 2.4.) The figure shows three alternative sizing assumptions, based on different design levels for excess electric power under peak conditions. For the horizontal line marked "0% margin," the system is sized so that at peak system output (and only at peak output), the reference dish system can just serve the on-site electrical load. Clearly, there will be no excess power sold back to the utility under these conditions. The vertical ordinate for this case is 0.200 kW_e/m^2. Defining this as the 0% margin case means that the system is sized against the on-site electric load so that there are $(0.200)^{-1} = 5.00 m^2$ of system for each kW_e of on-site electric load. Because this load is assumed to be steady, and because only excess power is assumed to be sold back to the utility (i.e., the

Table 2.4. Delivered Thermal and Electric Power Levels Dish Cogeneration System, Barstow Conditions

	Winter		Spring/Fall		Summer	
	Delivered Thermal Power kW_e/m^2	Delivered Electric Power kW_e/m^2	Delivered Thermal Power kW_e/m^2	Delivered Electric Power kW_e/m^2	Delivered Thermal Power kW_e/m^2	Delivered Electric Power kW_e/m^2
0500	-0-	-0-	-0-	-0-	-0-	-0-
0600	-0-	-0-	-0-	-0-	0.136	0.099
0700	-0-	-0-	0.127	0.092	0.186	0.166
0800	0.163	0.132	0.176	0.152	0.215	0.188
0900	0.205	0.182	0.197	0.176	0.221	0.191
1000	0.238	0.197	0.219	0.190	0.238	0.197
1100	0.245	0.200	0.215	0.188	0.238	0.197
1200	0.240	0.198	0.208	0.185	0.244	0.200
1300	0.227	0.194	0.201	0.179	0.220	0.190
1400	0.204	0.181	0.190	0.170	0.216	0.188
1500	0.175	0.151	0.173	0.149	0.202	0.188
1600	0.127	0.092	0.146	0.111	0.185	0.165
1700	-0-	-0-	0.073	0.049	0.162	0.131
1800	-0-	-0-	-0-	-0-	0.086	0.064
1900	-0-	-0-	-0-	-0-	-0-	-0-

NOTE: The thermal and electric power levels shown in this table are 60% and 90%, respectively, of the corresponding power levels in Tables 2.3, A-3, and A-4.

Table 2.5 Displaced Energy Profiles for Reference Dish System, Barstow Conditions

	Winter		Spring/Fall		Summer	
	Primary Fuels Displaced by Thermal Output Btu/m^2	Delivered Electric Energy kWh$_e$/m^2	Primary Fuels Displaced by Thermal Output Btu/m^2	Delivered Electric Energy kWh$_e$/m^2	Primary Fuels Displaced by Thermal Output Btu/m^2	Delivered Electric Energy kWh$_e$/m^2
0500						
	-0-	-0-	-0-	-0-	309.4	0.050
0600						
	-0-	-0-	290.5	0.046	734.6	0.133
0700						
	372.8	0.066	690.7	0.122	915.5	0.177
0800						
	841.5	0.157	825.5	0.164	995.0	0.190
0900						
	1014.2	0.190	951.1	0.183	1049.8	0.194
1000						
	1104.6	0.199	992.2	0.189	1088.2	0.197
1100						
	1107.4	0.199	967.6	0.187	1101.9	0.199
1200						
	1069.0	0.196	934.7	0.182	1060.8	0.195
1300						
	986.8	0.188	893.6	0.175	995.0	0.189
1400						
	866.2	0.166	830.5	0.160	956.6	0.184
1500						
	690.7	0.122	731.8	0.130	885.3	0.173
1600						
	290.5	0.046	501.6	0.080	794.9	0.148
1700						
	-0-	-0-	167.2	0.025	567.4	0.098
1800						
	-0-	-0-	-0-	-0-	197.4	0.032
1900						
Daily Total	8343.7	1.529	8804.0	1.643	11652.1	2.159
Seasonal Total (Daily x F)	0.751×10^6 (F=90)	137.61 (F=90)	1.611×10^6 (F=183)	300.67 (F=183)	1.072×10^6 (F=92)	198.63 (F=92)

NOTES: Displaced primary fuels for the thermal output component are computed from Gross Thermal Energy Produced in Tables 2.3, A-3, and A-4 as follows:

Efficiency of Thermal Transport System	0.86
Efficiency of Waste Heat Boiler	0.70
Efficiency of Conventional Gas-Fired Boiler	0.75
Btu per kWh$_t$	3415

Thus one gross kWh$_t$ displaces $\frac{(0.86)(0.70)}{0.75} \cdot 3415 = 2741$ Btu

"Delivered electric energy" includes exported energy as well as on-site consumption. The figures reflect 10 percent loss from the Gross Electric Energy Produced figures in Tables 2.3, A-3, and A-4, due to system parasitic power requirements.

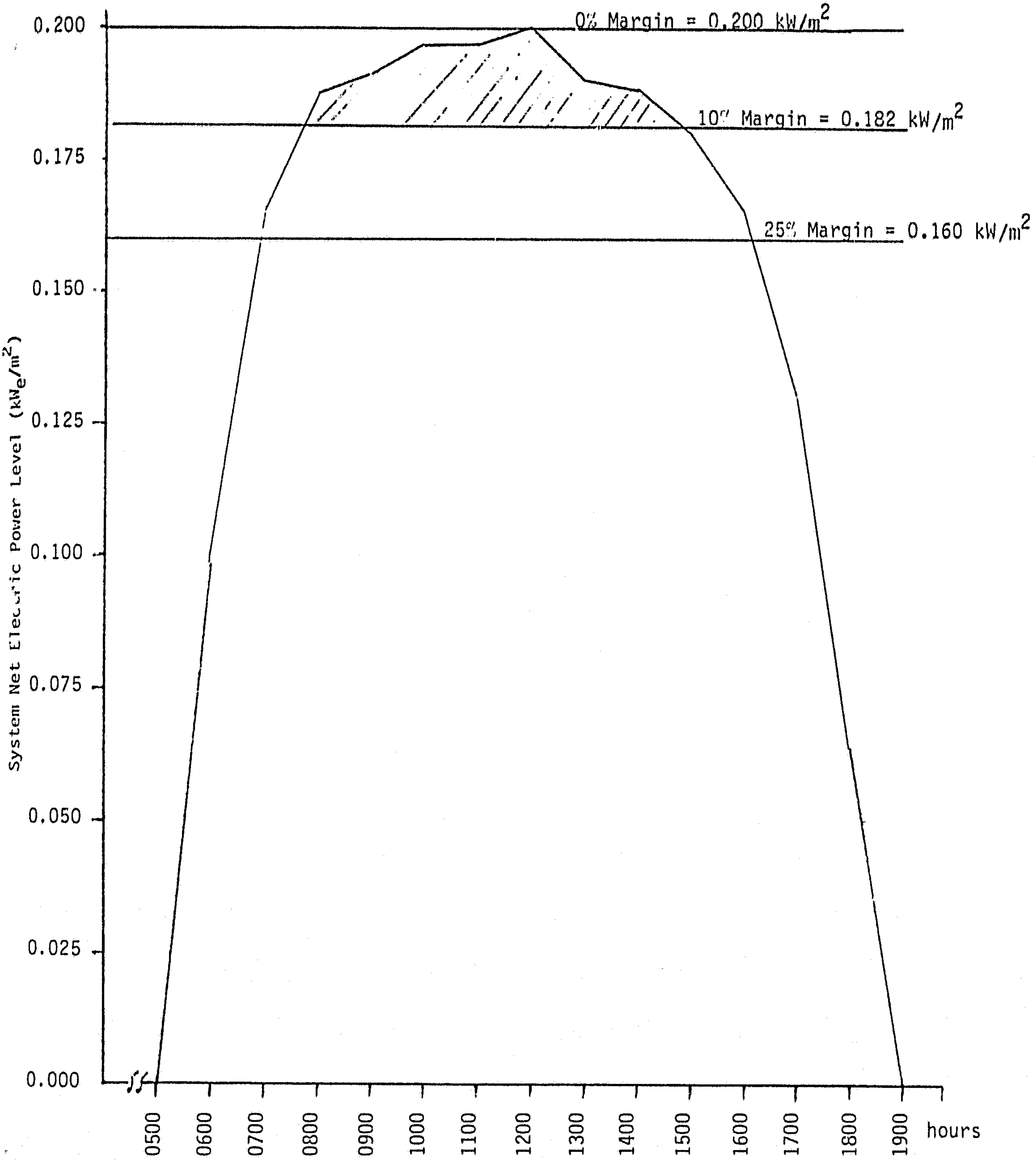

Figure 2.3. Net Electric Power Profile. Barstow Summer Conditions: Export Power Component under 0%, 10%, and 25% Peak Margin Conditions

system owner is never simultaneously buying and selling power), this situation will never produce a sell-back condition.

In the "10% margin" case, the electric output at peak is 10% in excess of the on-site load. In this case, the assumed system size is $(0.182)^{-1} = 5.49m^2$ for each kW_e of on-site electric load. As might be expected, electric output for this larger system is sufficient to create a sell-back condition. For a typical day in the Summer season, the electricity sold back is measured on Figure 2.2 by the shaded area bound from above by the power level curve, and from below by the horizontal "10% margin" line. (Similar excess power calculations were performed for the Winter and Spring/Fall seasons. They are shown in Appendix A.)

Finally, the "25% margin" case assumes a system of $(0.160)^{-1} = 6.25m^2$ per kW_e of on-site electric load. This system produces, at peak, 25% more power than is required on-site, and for a typical summer day for Barstow conditions, would permit sell-back energy equal to the area under the curve and above the "25% margin" line.

A few comments are appropriate regarding this technique for determining the export share of electricity produced by the cogeneration system. First, the method abstracts totally from any characteristics of the electricity use patterns of individual industries or firms. On-site electric load is assumed to be invariant with time. While this may be a good planning assumption for early markets, it clearly represents no attempt whatsoever to reschedule electricity consumption to minimize total electricity cost to the user. Such energy management strategies, if feasible, could substantially increase the value of systems producing electricity from "free" fuels.

Second, the approach is driven entirely by the peak electric margin criterion for system sizing and is completely independent of such potentially relevant considerations as the proportions in which thermal and electric energy are used, and relative prices for gas, purchased electricity, and sold-back electricity. This sizing approach was selected, with the consent of JPL, after an attempt to reflect more industry-specific concerns (i.e., the ratio of thermal energy consumed to electric energy consumed) was judged to be inappropriate. The underlying lesson is that appropriate design, and resultant value, of any cogeneration system will be highly application-specific. Con-

sequently, general overview studies, like this one, can only hope to capture general influences on system value.

2.2.2 Adjusting System Performance to Non-Barstow Locations

Thus far, all system performance calculations, including excess power production, have assumed Barstow insolation conditions. This section explains the process used to rescale those calculations to the Arizona Public Service (APS) and Southern California Edison (SCE) locations used to perform the value analysis. Essentially, this scaling consists of adjusting for the percentage differences in total yearly insolation between Barstow and other sites, without any changes assumed in the insolation pattern. Thus, each alternative site is assumed to be a perfect "scale model" of Barstow, where the scale is determined by the ratio of total yearly insolation levels at the two sites.

The top half of Table 2.6 shows seasonal and yearly average insolation levels for a variety of southwestern sites. The lower half of the table shows these same sites assigned to utility service territories, and presents their seasonal and yearly average insolation measures divided by the corresponding Barstow measures. The annual ratios (i.e., 0.95 for APS, 0.80 for SCE) are the scalars used to adjust Barstow dish system performances to the APS and SCE service territories. (The ratios for other sites are presented for comparison and for the use of anyone who wishes to extend the analysis to other southwestern sites.)

Because the Barstow performance profiles are scaled linearly, without changing their shapes, the scalar adjustment factor simply "passes through" all the previous calculations, including those for export electricity. (This result is less a reflection of reality than of the abundance of linear assumptions adopted for this study.) These adjustments to the Barstow energy displacement figures will be discussed further in Section 2.4, Value and Breakeven Analysis.

2.3 ENERGY RATE STRUCTURES ASSUMED FOR THE STUDY

One of the most fundamental influences on value for a renewable energy system is the value per unit of displaced fuels. As examination

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Table 2.6. Scalar Adjustments of Barstow Insolation Values to Other Southwestern Sites and Service Territories

A comparison of the 1976 Barstow data to SOLMET direct normal insolation shows:

	Summer J,J,A (kWh/m2/day)	Winter D,J,F (kWh/m2/day)	Spring/Fall S,O,N,M,A,M (kWh/m2/day)	Annual (kWh/m2/yr)
Barstow, CA	8.875	6.409	6.943	2,663.9
Mean-daily insolation at representative SOLMET sites:				
Ft. Worth, TX	5.9	3.7	5.3	1,706
Midland, TX*	7.7	5.8	7.0	1,504
El Paso, TX	8.1	6.0	7.5	2,646
Albuquerque, NM	8.2	5.8	7.6	2,600
Phoenix, AZ	8.0	5.3	7.3	2,528
Santa Maria, CA	6.9	4.1	6.1	1,998
Fresno, CA**	7.9	3.5	6.6	2,240

Therefore, the appropriate scalar adjustments from 1976 Barstow insolation (and therefore performance) to other service territories are:

Utility	Summer	Winter	Spring/Fall	Annual
Arizona Public Service (Phoenix)	0.90	0.83	1.05	0.95
Dallas Power and Light (Ft. Worth)	0.66	0.58	0.76	0.64
El Paso Electric Company (El Paso)	0.91	0.94	1.08	0.99
Public Service of New Mexico (Albuquerque)	0.92	0.90	1.09	0.98
San Diego Gas and Electric (Santa Maria and Phoenix)	0.84	0.73	0.97	0.85
Southern California Edison (Fresno and Santa Maria)	0.83	0.59	0.91	0.80
Texas Electric Service (Midland)	0.87	0.90	1.01	0.94

* Taylor, R.W., 1979. Solar Thermal Repowering Utility Value Analysis. SERI/TR-8016-1, Golden, CO: Solar Energy Research Institute, p.39. Midland, TX is not a SOLMET site but has been correlated in this study to long-term weather data and to SOLMET recordings at El Paso, TX.

**Berdahl, et al., 1977. California Solar Data Manual. San Mateo Solar Energy Information Service; revised per Melton, W.C., 1978. Performance Value and Cost of Solar Thermal Electric Central Receiver Plants Outside of the Southwest. ATR-78(7689-04)-1. El Segundo, CA: Aerospace Corporation.

Source: Boes, E.C., et al., 1978. "Availability of Direct, Total, and Diffuse Solar Radiation to Fixed and Tracking Collectors in the U.S.A.," SAND77-0885, Revised. Albuquerque, NM Sandia Laboratories.

of the recent history of prices for both primary fuels and electricity clearly shows, there is room for considerable variation in estimates of the future prices of fuels. In the case of cogeneration, this uncertainty is compounded by provisions of the Public Utilities Regulatory Policy Act requiring "non-discriminatory" terms of purchase by utilities of excess cogenerated power. The concept of "avoided cost" rates may dictate utility buy-back at rates reflecting the most expensive generation operating at the time of purchase. What is not clear at present is the extent to which such rates will be adjusted for capacity factor considerations and how quickly (or if) they will decline as the host utility's generation mix changes.

It was not the intent of this study to do a detailed sensitivity analysis of alternative rate structures merely to "rediscover" the importance of the unit values of displaced energy in determining system value. Accordingly, only one set of energy prices is examined for each service area. However, the two service areas selected, APS and SCE, do have sufficient variation for some first-order conclusions on this factor.

2.3.1 Price Assumptions for Natural Gas

Natural gas prices for both cases (APS and SCE) were taken from the first report of the Solar Thermal Cost Goals Committee, August 1980. The prices used for the analysis were for 1985, denominated in 1980 dollars. They were obtained as follows:

The Cost Goals Committee reported delivered-to-industry gas prices as of 1979, adjusted to 1980 dollars, as:

Mountain Region (Used for APS)	\$2.33 per million Btu
Pacific Region (Used for SCE)	\$3.11 per million Btu

The Cost Goals Committee further recommended the use of a 7.4 real rate of escalation in natural gas prices over the 1980-1900 time period. Thus, the 1985 gas prices used as the basis for this study are:

APS $(2.33)(1.074)^6$ = \$3.58 per million Btu

SCE $(3.11)(1.074)^6$ = \$4.77 per million Btu

Because real (as opposed to nominal) escalation rates were used, these estimates of 1985 prices are still measured in 1980 dollars. The Cost Goals Committee projected declines in real gas price escalation to 4.7 percent in the 1991-2000 interval, and to 2.3 percent in the 2001-2025 interval. For the 20 year analysis period (1985-2004) adopted for this study, the escalation rate selected by JPL and SAI was the composite effective rate implicit in the Cost Goal Committee assumptions. Thus, the annual rate, r*, was found as:

$$r^* = \left[(1.074)^5 (1.047)^{10} (1.023)^5\right]^{1/20} = 1.048$$

In the value analysis performed below, this was rounded to a 5% real escalation rate on top of an assumed 10% rate for annual inflation. Thus, in nominal terms, the rate of increase gas price was assumed to be 15%. This assumption was applied to both service areas.

2.3.2 Electricity Price Assumptions for Arizona Public Service

Retail rates for APS industrial customers are determined by a combination of an energy charge and a peak use or demand charge. Both the energy charge and the demand charge vary according to level of use. This variation necessitates study assumptions on monthly peak demand and on monthly energy use in order to assign values to energy displacement and peak demand reduction due to the solar cogeneration system. The assumptions agreed upon with JPL are:

Peak Electricity Demand	150 kW_e
Monthly Electricity Consumption	32,000 kWh_e

The monthly consumption figure is consistent with two-shift operation at 40 hours per shift-week, for four weeks per month, at an average demand of 100 kW_e.

According to the APS rate schedule for industrial rates, filed February 3, 1981, the rates corresponding to the demand and consumption levels given above are:

- For each kW_e of peak demand over 3kW, the customer is charged for 115 kWh_e of additional monthly consumption.
- Energy charge is $0.04068 per kWh_e up to a monthly demand of 42,000 kWh_e.

Together, the two rates imply that a reduction of $1kW_e$ in peak demand is worth (115)(0.04068) = \$4.68 per month, or \$56.16 per year. The electricity price quoted is in 1981 dollars. To convert these published rates to 1985 price estimates, and then express them in 1980 dollars, the following adjustments were made. The published 1981 rate was escalated for four years at a <u>nominal</u> rate of 12.6% (equal to the Cost Goals Committee's recommended 2.6% real escalation rate plus a 10% value for general inflation), then deflated for five years at 10%. Thus:

1985 estimate of APS industrial rate for customers whose monthly consumption is >3500kWh_e, <45,500 kWh_e, expressed in 1980 dollars.	$0.04068 \dfrac{(1.126)^4}{(1.10)^5} = 0.04060$

The two adjustments very nearly cancel out (i.e., four years of escalation at 12.6% almost exactly offsets 5 years' deflation at 10%). The adjusted yearly value of a $1kW_e$ reduction in peak demand is \$56.03.

APS has published a set of avoided energy cost rates in compliance with Section 210 of PURPA. The schedule gives a time-phased set of rates, denominated in 1980 dollars, for 100 mw of power purchased from qualifying facilities. For 1985, the rates are:

$/kWh_e$ (1980 dollars)

Summer (May 16-Oct. 15)		Winter (Oct. 16-May 15)	
On-Peak (9am-10pm)	Off-Peak (10pm-9am)	On-Peak (7am-10pm)	Off-Peak (10pm-7am)
0.03767	0.01386	0.01399	0.01078

Since most of the export energy would be produced on-peak in the summer, a weighted average of the summer peak and winter peak rates was used for the value analysis. Arbitrary weights of 2/3 for the summer rate and 1/3 for the winter rate were chosen. Thus, the rate used for exported electricity was:

$$\frac{2(0.03767) + 0.01399}{3} = 0.02978$$

Ideally, the production of export electricity should be modeled hour by hour, as should the utility buy-back rate schedule, and export electricity values assigned accordingly. Given the preliminary nature of the

PURPA filings, the highly averaged insolation data, and the overview nature of this study, this was not done.

The last estimate to be made is of the reduction in monthly peak load contributed by the cogeneration system. This is a first-order effect of system size, and will be addressed with each individual system size case in the value analysis section.

2.3.3 Electricity Price Assumptions for Southern California Edison

According to SCE Rate Schedule GS2 (20-200 kW peak demand), the relevant SCE rates are (in 1981 dollars):

$$\text{Energy Charge} \quad (\underset{\text{fuel component}}{0.04012} + \underset{\text{capital component}}{0.0138}) = \$0.05392/\text{kWh}_e$$

Demand Charge $3.80 per kW of peak demand per month.

These rates are for 1981, and denominated in 1981 dollars. To adjust them to 1985 estimates, measured in 1980 dollars, the same $\left[(1.126)^4/(1.10)^5\right]$ adjustment factor used in the APS case is applied. Accordingly, the rates used for SCE in the value analysis are:

Energy Charge: $0.05382/kWh$_e$

Demand Charge: $45.52 per year per kW$_e$ reduction in peak demand

According to M. J. Vogeler, SCE Supervisor for Cogeneration and Small Power Projects, the followin~ avoided cost proposal was current as of May, 1981 (all amounts are in 1981 dollars):

On-Peak		
1pm - 7pm	May 1 - October 31	$0.066
5pm - 10pm	November 1 - April 30	
Mid-Peak		
9am - 1pm 7pm - 11pm	May 1 - October 31	$0.060
8am - 5pm	November 1 - April 30	
Off-Peak		
11pm - 9am	May 1 - October 31	$0.058
10pm - 8am	November 1 - April 30	

Because a very high proportion of system output would fall in the Mid-Peak category, with summer afternoons on-peak and both summer and winter early mornings off-peak, a rate slightly above Mid-Peak rate was chosen ($0.062/kWh$_e$). When adjusted by the same factor used to "escalate to 1985, deflate to 1980" above, the rate used to value export electricity was still $0.062/kWh$_e$.

2.4 VALUE AND BREAKEVEN ANALYSIS

2.4.1 Overview

The general procedure used for value analysis in this study is to first compute the present value of the combined energy displacement/ energy export benefits from the cogeneration system over the twenty-year evaluation period adopted for the study. This total present value is called "gross system value." An estimate of the present value of operating and maintenance (O&M) costs over the evaluation period is deducted from gross system value to produce "allowable installed cost," interpreted as the maximum installed system cost that could be sustained without the present value of the costs of the system exceeding the present value of system benefits. Using assumptions about balance of system (BOS), and installation costs (where installation costs are broadly defined to include site preparation, engineering fees, contingency, etc.), a value can be determined for "allowable FOB factory cost." This amount is used as a demand side value figure for comparison with supply side estimates of technology cost. For purposes of the study, BOS costs were fixed at $51/m^2 (i.e., they were assumed to be invariant with respect to FOB system cost. A burden rate on direct costs of 8% was applied to cover engineering and office costs, freight, and sales and use tax. On top of these, another 18% was applied for contingency plus fee.

2.4.2 Present Values of Displaced and Exported Fuels

For each fuel displaced or exported, a constant yearly amount (in MBtu/m^2 or kWh$_e$/m^2) is specified, along with a corresponding first year price and an escalation rate assumed to apply over the entire evaluation period. If we represent the value of first year savings (i.e., first-year price times the constant quantity) of theith fuel as $\$FL_i$, and the corresponding escalation rate as g_i, then the present value of the entire stream of savings for this particular fuel may be represented as:

$$PVFL_i = \$FL_i \left\{ \frac{1+g}{k-g} \left[1 - \left(\frac{1+g_i}{1+k} \right)^n \right] \right.$$

where k is the rate of discount used and n is the number of years in the evaluation period. The term enclosed in the {} brackets is the Present Value Factor for a Gradient Series, and is a function of the escalation rate for the particular fuel (g_i), the length of the evaluation period (n), and the discount rate used (k). For purposes of this study, the evaluation period is assumed fixed at 20 years, and three values for the discount rate will be considered (15, 20, and 25 percent). Thus for any given case, the term in brackets will be a function of g_i alone. We can then simplify our notation by representing the bracketed expression as G_i. Using this compact notation for the present value factor for a gradient series, we represent the present value of all fuel savings combined as:

$$\Sigma(PVFL_i) = \Sigma(\$FL_i \cdot G_i)$$

Note that a fuel can be electricity as well as gas, and that the procedure can incorporate "revenues" from energy exports as well as savings from reduced energy purchases.

2.4.3 Present Value of Operating and Maintenance (O&M) Costs

From a mathematical perspective, O&M costs as assumed for this study have identical characteristics to fuel savings: a stream that is constant in physical terms, but whose unit price grows at a constant percentage rate over the evaluation period. Representing the first-year value for O&M costs as \$OM, the present value of O&M costs over the entire evaluation period is:

$$PVOM = \$OM \cdot G_{om}$$

G_{om} is calculated by the same expression as for G_i above, with the escalation rate for O&M used in place of g_i.

In the absence of better data, O&M costs in the first year were assumed to be 2% of installed capital cost of the system, and to escalate at 10% per year (equal to the general inflation rate) over the evaluation period.

2.4.4 Allowable Installed Cost

Allowable installed cost is found as the solution for capital cost (CPCST) for the life-cycle breakeven condition:

$$CPCST\ (FCR/CRF) + PVOM = \Sigma(PVFL_i)$$

The only new terms in this expression, FCR and CRF, will be discussed

below. They relate to the inclusion of other capital-related costs (aside from purchase price plus installation) and adjustment from a stream of expenditures to a single present value for the whole stream. The interpretation of the condition is straightforward: at the break-even point, the sum of capital-related and O&M costs equals the energy displacement benefits. All magnitudes are expressed on a present value basis. When CPCST is determined as the solution to the breakeven condition (for fixed values of the other inputs), the solution value gives the maximum value CPCST can have without causing the life-cycle costs of the system to exceed the life-cycle benefits.

The most complex term in the life-cycle breakeven condition is FCR, the Fixed Charge Rate. The FCR is applied to investment in the system to determine the annualized contribution of capital-related charges (interest, return on equity and retirement of both equity and debt, tax effects on interest and profits, property taxes and capital-related insurance). The formulation of the FCR used for this study is:

$$FCR = \frac{CRF1}{1-\tau}\left[(1-f) + f(1-\tau)\frac{CRF2}{CRF3} + \frac{f\tau}{1+r}\;\frac{CRF2 - r}{CRF4} - \frac{\alpha}{1+R} - \tau \cdot DPF\right]$$

where: τ = effective composite state/federal corporate income tax rate,

f = fraction of system investment financed by loan,

r = interest rate on loan,

R = after-tax return on equity invested in the system,

α = investment tax credit,

DPF = present value factor for depreciation claims,

CRF1 = capital recovery factor using R and system life,

CRF2 = capital recovery factor using r and loan duration,

CRF3 = capital recovery factor using R and loan duration,

CRF4 = capital recovery factor using R" and loan duration, and

$$R'' = \frac{1+R}{1+r} = 1.$$

This expression is more complex than the FCR formulation developed in the JPL "USES" document (JPL 5040-29) for utility-owned systems. The additional complexity results from keeping the rate of interest on debt and the rate of return on equity separate. (USES employed a weighted average of interest rates.) This reflects the unregulated nature of conventional industries, increased interest in the tax situation of industrial system owners, and a formulation of FCR which lends itself to the explicit examination of the cost effects of various combinations of financial leverage. (The reader wishing an explanation of this "industrial FCR" is referred to: W. C. Dickinson and K. C. Brown: Economic Analysis of Solar Industrial Process Heat Systems, Lawrence Livermore National Laboratory, UCRL-52814 Rev. 1, August 11, 1981.)

Multiplying invested capital by the FCR produces a uniform yearly (or "annualized") amount for capital-related charges. Dividing by the CRF (Capital Recovery Factor) collapses this stream of yearly charges into a single present value. The capital recovery factor is a standard concept in finance and in engineering economics used to translate back and forth between lump sums and uniform yearly flows of equivalent present value. The formula for the CRF is:

$$CRF_{k,n} = \frac{k}{1-(1+k)^{-n}}$$

where k is the interest rate per period and n is the number of periods over which the uniform flow occurs. The industrial FCR uses four different CRF's, based on different permutations of return on equity, interest rate on borrowed capital, duration of loan and system life. The purpose of this proliferation of terms is, as mentioned above, to measure explicitly and more accurately (compared to a weighted cost of capital FCR) the cost effects of different combinations of debt and equity in financing the investment.

For purposes of this study, all but one of the parameters of the FCR expression were agreed upon with JPL. Sensitivity analyses on the after-tax return on equity were performed at 15, 20, and 25 percent.

The results found for allowable installed cost for both the APS and SCE cases will be discussed in Section 3.

2.4.5 Baseline Economic Assumptions

Many of the economic values important to the analysis have been addressed above. The last important category of economic variables to be specified pertains to the financial and tax circumstances of what we take, for purposes of this study, as the typical firm. These values are given in Table 2.7.

Table 2.7. Study Assumptions on the Economic Environment of the "Typical Owner" of a Parabolic Dish Cogeneration System

Amount of Financial Leverage Assumed for Breakeven Calculations	None
Composite Federal/State Corporate Income Tax Rate	50%
Investment Tax Credit Applicable to a Solar Cogeneration System	20%
System Accounting Life for Tax Purposes	7 Years
Method of Depreciation Used for Tax Purposes	Sum-of-Yrs.-Digits
Applicable Property Tax Rate	2.5%

3.0 RESULTS OF THE ANALYSIS

Section 2.0 explained the analytical procedures used in this study. This section presents the results of applying those procedures to the data on energy costs and inflation levels taken as typical of the Arizona Public Service (APS) and Southern California Edison (SCE) service territories. The supporting calculations are presented in detail in Appendix B. Tables 3.1 and 3.2 summarize the value results in terms of allowable installed system cost and allowable FOB module cost, respectively. Because it does not necessitate assumptions about the split between module and balance of system (BOS) costs, or about indirect cost and contingency allowances, Table 3.1 will be used as the basis for this discussion. (Table 3.2 is derived from Table 3.1 by assuming a fixed $51/m^2$ for BOS cost, and burden rates for indirects and contingency totaling 27.4%. Therefore, an entry in Table 3.2 ($M) is related to the corresponding entry in Table 3.1 ($S) by: $S = 1.274 ($M + 51). Focusing on Table 3.1 keeps the assumed values of 1.274 and $51/m^2$ out of the debate for the present. Any comparison of technology values to achievable factory costs will, of course, immediately reintroduce these issues.)

3.1 RESULTS

Table 3.1 shows higher allowable costs (values) under the SCE assumptions than for APS, in spite of the superior solar resource assumed for APS. This is primarily due (as examination of the detailed calculations in Appendix B will show) to two readily understood differences:

- Natural gas prices are assumed higher for SCE ($3.11 vs. $2.33 per MBtu).
- Displaced electricity is more valuable under the SCE assumptions ($0.05382 vs. $0.0406 per kWh_e).

Partially moderating this difference is the fact that a kW_e reduction in peak demand is worth more over the course of a year on the APS system than on SCE's system [115 (0.0406) 12 = $56.03 vs. (3.80) 12 = $45.52]. Table 3.1 also shows a slight tendency for the SCE advantage to grow with larger system sizes. Comparing the 20% discount rate case in both instances,

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Table 3.1. Allowable Installed Cost for Dish Cogeneration System ($\$/m^2$, system)

		APS	SCE
0% Peak Electric Margin			
Discount Rate:	10%	615.24	674.33
	15%	410.69	450.01
	20%	283.79	310.88
	25%	205.38[a]	224.93
10% Peak Electric Margin			
Discount Rate:	10%	630.92	690.99
	15%	421.27	461.25
	20%	291.17	318.72
	25%	210.76	230.65
25% Peak Electric Margin			
Discount Rate:	10%	650.19	718.26[b]
	15%	434.27	479.64
	20%	300.24	331.55
	25%	217.37	240.01

a Minimum value in table

b Maximum value in table

Table 3.2. Allowable FOB Factory Costs for Dish Cogeneration System ($/m2, module)

		APS	SCE
0% Peak Electric Margin			
Discount Rate:	10%	431.77	478.14
	15%	271.27	302.12
	20%	171.69	192.94
	25%	110.15	125.50
10% Peak Electric Margin			
Discount Rate:	10%	444.07	491.20
	15%	279.56	310.93
	20%	177.47	199.09
	25%	114.38	129.99
25% Peak Electric Margin			
Discount Rate:	10%	459.19	512.60
	15%	289.76	325.37
	20%	184.59	209.16
	25%	119.57	137.33

the ratio of APS/SCE value falls from (283.79/310.88) = 0.9129 for the 0% electric margin system to (300.24/331.55) = 0.9056 for the 25% electric margin system. This change occurs, despite the greater influence of demand charge adjustment on the APS system, because of very different circumstances of the two systems with respect to exported power. For the APS assumptions, exported power is worth less than displaced on-site consumption ($0.02978 vs. $0.0406 per kWh_e). Under the SCE assumptions, the opposite is true ($0.062 vs 0.06382 per kWh_e). Thus the growing share of electric energy production that goes to exports as system size increases serves by itself to increase per m^2 values under SCE assumptions and decreases them under APS assumptions. The larger APS systems actually show slight increases in value/m^2 because of the effect of the demand charge adjustment. Again holding the discount rate constant at 20%, the value per m^2 of produced electricity (displaced plus exported) is lower for the APS 25% electric margin system than for the 0% margin system ($250.51 vs. $257.43). Overall system value increases because of a more-than-offsetting doubling in the assumed value of the demand charge savings ($58.67 vs. $29.34).

To put all of this in perspective, it should be noted that, for a fixed discount rate, the differentials in system value of Table 3.1 never exceed about 10 percent. While this is partly due to the face that a rather narrow range of system sizes was considered, unless the cogenerated electricity cannot be entirely used on-site, the marginal contribution of electricity sell-back is a function of the difference between the values of displaced and exported electricity. For the cases considered, these differences do not get very large (roughly 4¢ vs. 3¢ for APS, 5.4¢ vs. 6.2¢ for SCE). Given the amount of kWh_e produced annually per m^2 of dish (roughly 600 for the APS assumptions), a differential of a penny per kWh_e does not provide much stimulus to system value.

A traditional and truly first-order influence on system value is provided by the discount rate. The system values under 25 percent discounting of fuel savings are in every case only about a third of their value under 10 percent discounting. The 10 percent case is clearly too low to be realistic (given an assumed 10 percent rate of general inflation, 10 percent discounting implies a zero real rate of return). It has been included to further illustrate the sensitivity of life-cycle value analysis to discount rate assumptions.

3.2 SYNTHETIC DEMAND CURVES FOR PDS SYSTEMS

The allowable cost numbers for PDS technology in the previous section were based on varying assumptions on the percentage by which peak PDS electric output exceeded on-site electric demand. The absolute sizes of output, demand, and peak margin were never specified. While this ratio approach yields valid value results so long as all PDS thermal output serves to reduce on-site consumption of thermal fuels, it avoids the important issue of the dependence of PDS marginal value on the quantity of PDS technology installed. It is clear from the previous section that if a PDS system were installed of sufficient size that some thermal output could not be used, part of the source of system value would be lost. Similarly, with different values for on-site electricity displacement and export electricity, the contribution of electricity production to system value is a function of the allocation of PDS electricity production between those two categories. The system sizing assumptions of the last section addressed the electricity allocation problem, but explicitly assumed that all thermal output could be used. This section describes an approach that allows the evaluation of systems for which some thermal output must be discarded.

3.2.1 Producing System Value Curves as Functions of System Size

Computing size-dependent measures of system value under given weather and economic circumstances is a four step process.

Step One — Define the absolute levels of on-site demand for thermal and electric energy for each industry application.

Step Two — Simulate, on an hour-by-hour basis, the allocation of PDS energy outputs to thermal energy displaced, thermal energy dumped (i.e., having no economic value), electric energy displaced, and electric energy exported.

Step Three — Assign appropriate economic values to the respective energy quantities of Step Two, on both a first-year and a present-value basis.

Step Four — Derive allowable installed PDS system costs for each of the combinations of system size, industry application, and location evaluated.

The energy demand levels of Step One are given in Tables 3.3 and 3.4 The basic procedure for assigning PDS energy outputs for a single hour is described in Table 3.5. Given values for on-site thermal and electric demand (DT and DE, respectively), the assignment of proper values to PDS thermal and electric outputs is a function of separating those outputs into the portions used on-site (with values P_t and P_e) and those amounts in excess of on-site use (with values 0 and P_x). In order to capture the weather-dependence of PDS output in this exercise, such allocations must be performed for each hour contained in the weather data base used in the study. These hourly results are then accumulated into yearly totals, which are used to determine the present values of fuels displaced and exported, as explained in 2.2 above.

The input variables in Table 3.5 have been defined and quantified above, with the exceptions of DT, DE, and S. Quantification of these variables is discussed in the next section. For simplicity in applying the procedure, the PDS hourly energy output data of Table 2.5, converted to units appropriate to the procedure in Table 3.5 are presented in Table 3.6.

TABLE 3.3 CALCULATION OF AVERAGE ESTABLISHMENT USE OF THERMAL FUELS AND ELECTRICITY FOR FIVE INDUSTRIES IN ARIZONA AND CALIFORNIA

Industry, SIC Code, and National Thermal/Electric (T/E) Ratio	Metal Coating SIC 3479 T/E = 0.93	Fluid Milk SIC 2026 T/E = 1.5	Motor Vehicles SIC 3711 T/E = 3.5	Bread, Cake SIC 2051 T/E = 4.5	Industrial Organic Chemicals SIC 2869 T/E = 13.0
ARIZONA					
Total Thermal Fuels Purchased by Establishments in this SIC (10^9 Btu/yr)	26	65	289	160	576
Number of Establishments in SIC	11	10	1	20	2
Average Use of Thermal Fuels per Establishment (10^9 Btu/yr)[a]	2.36	6.50	289	8	288
Average Use of Electricity per Establishment (10^6 kWh/yr)[b]	0.74	1.27	24.2	0.521	6.49
CALIFORNIA					
Total Thermal Fuels Purchased by Establishments in this SIC (10^9 Btu/yr)	1,683	1,594	2,899	3,352	15,358
Number of Establishments in SIC	213	103	45	127	38
Average Use of Thermal Fuels per Establishment (10^9 Btu/yr)[a]	7.90	15.5	64.4	26.4	404
Average Use of Electricity per Establishment (10^6 kWh/yr)[b]	2.49	3.03	5.39	1.72	9.11

[a] Average Use of Thermal Fuels computed by dividing Total Thermal Fuels Purchased by Number of Establishments.

[b] Average Use of Electricity computed by dividing Average Use of Thermal Fuels by Industry T/E ratio, then dividing by 3.413 to convert to (10^6 kWh/yr).

SOURCES: Krawiec, F. et al, "Energy End-Use Requirements in Manufacturing," SERI/TR-733-790R, Solar Energy Research Institute, July 1981.
Hooker, D.; West R., "Industrial Process Heat Case Studies," SERI/TR-333-323, Solar Energy Research Institute, October 1980.

TABLE 3.4 THERMAL AND ELECTRIC POWER DEMANDS OF AVERAGE ESTABLISHMENTS IN FIVE INDUSTRIES IN ARIZONA AND CALIFORNIA

	Metal Coating SIC 3479	Fluid Milk SIC 2026	Motor Vehicles SIC 3711	Bread, Cake SIC 2051	Industrial Organic Chemicals SIC 2869
ARIZONA					
Thermal Demand (MBtu/hr)	0.567	1.56	69.5	1.92	69.2
Electric Demand (kW)	178	305	5820	125	1560
CALIFORNIA					
Thermal Demand (MBtu/hr)	1.90	3.73	15.5	6.35	97.1
Electric Demand (kW)	599	728	1300	413	2190

Hourly demands computed by dividing the corresponding annual average use values of Table 3.3 by 4160 hours. This figure reflects the assumption that all plants operate 5 days a week for 52 weeks per year, at 16 hours per day. Thus, the assumed operating hours per year are:

$$(52)(5)(16) = 4160.$$

TABLE 3.5 Procedure for Hourly Assignment of Values to PDS Energy Outputs

Definitions

DT	On-site demand for delivered thermal energy in MBtu/hr.
DE	On-site demand for electricity in kW_e.
t_i	PDS thermal energy production during hour i in delivered $(MBtu/hr)/m^2$.
e_i	PDS electric energy production during hour i in delivered kWh_e/m^2.
η_t	Thermal efficiency of conversion of fossil fuels to delivered thermal energy (used to convert delivered PDS thermal output to fuels displaced).
S	Size of PDS in m^2 of collector area
P_t	Value of thermal fuel in \$/MBtu.
P_e	Value of displaced electricity in $\$/kWh_e$.
P_x	Value of exported electricity in $\$/kWh_e$.
VT_i, VE_i, V_i	Monetary values at hour i of PDS thermal, electric, and combined energy outputs.

To compute monetary value of PDS thermal output at hour i:

$St_i - DT \leq 0$? (i.e., is this hour's thermal output less than on-site demand?)

<u>Yes</u> $VT_i = P_t St_i/\eta_t$

<u>No</u> $VT_i = P_t DT/\eta_t$.

To compute monetary value of PDS electric output at hour i:

$Se_i - DE \leq 0$? (i.e., is this hour's electric output less than on-site demand?)

<u>Yes</u> $VE_i = P_e Se_i$

<u>No</u> $VE_i = P_e DE + P_x(Se_i - DE)$

Combined monetary value is simply:

$$V_i = VT_i + VE_i \ .$$

TABLE 3.6 Hourly Energy Production for Reference PDS, Barstow Condition

	Winter		Spring/Fall		Summer	
	t_i Delivered Thermal Energy MBtu/m^2	e_i Delivered Electric Energy kWh$_e$/m^2	t_i Delivered Thermal Energy MBtu/m^2	e_i Delivered Electric Energy kWh$_e$/m^2	t_i Delivered Thermal Energy MBtu/m^2	e_i Delivered Electric Energy kWh$_e$/m^2
0500–0600	0	0	0	0	2.315×10^{-4}	0.050
0600–0700	0	0	2.172×10^{-4}	0.046	5.491×10^{-4}	0.133
0700–0800	2.787×10^{-4}	0.066	5.163×10^{-4}	0.122	6.844×10^{-4}	0.177
0800–0900	6.290×10^{-4}	0.157	6.372×10^{-4}	0.164	7.438×10^{-4}	0.190
0900–1000	7.581×10^{-4}	0.190	7.110×10^{-4}	0.183	7.848×10^{-4}	0.194
1000–1100	8.257×10^{-4}	0.199	7.417×10^{-4}	0.189	8.135×10^{-4}	0.197
1100–1200	8.278×10^{-4}	0.199	7.233×10^{-4}	0.187	8.237×10^{-4}	0.199
1200–1300	7.991×10^{-4}	0.196	6.987×10^{-4}	0.182	7.930×10^{-4}	0.195
1300–1400	7.376×10^{-4}	0.188	6.680×10^{-4}	0.175	7.438×10^{-4}	0.189
1400–1500	6.475×10^{-4}	0.166	6.208×10^{-4}	0.160	7.151×10^{-4}	0.184
1500–1600	5.163×10^{-4}	0.122	5.471×10^{-4}	0.130	6.618×10^{-4}	0.173
1600–1700	2.172×10^{-4}	0.046	3.750×10^{-4}	0.080	5.942×10^{-4}	0.148
1700–1800	0	0	1.250×10^{-4}	0.025	4.241×10^{-4}	0.098
1800–1900	0	0	0	0	1.475×10^{-4}	0.032
Daily Total	6.237×10^{-3}	1.529	6.581×10^{-3}	1.643	8.710×10^{-3}	2.159
Seasonal Total (F x Daily Total)	5.613×10^{-1} (F=90)	137.6 (F=90)	1.204 (F=183)	300.7 (F=183)	8.013×10^{-1} (F=92)	198.6 (F=92)

Yearly Totals = Σ(Seasonal Totals)
Delivered Thermal Energy 2.567 MBtu/m^2
Delivered Electric Energy 636.9 kWh$_e$/m^2

Note: The electric energy figures in this table are 90 percent of the corresponding values in Tables 2.3, A-3, and A-4. Delivered thermal energy is computed by multiplying the corresponding totals from those tables by: (0.60)(3415) = 2049 Btu/KWh$_t$.

3.2.2 Results of the Synthetic Demand Curve Analysis

The size-dependent measures of system value for the five industries studied are presented in Table 3.7 for both Arizona and California conditions. As before, these $\$/m^2$ costs represent, for each case, the maximum cost that could be sustained for an installed PDS system without the life-cycle costs of the system exceeding the present value of its life-cycle energy displacement. Again, note that these are not allowable f.o.b. hardware costs. (If desired, f.o.b. hardware costs can be produced by the same method used for Table 3.2 above.) Among the most interesting conclusions that can be drawn from Table 3.7 are:

- The relative values of displaced electricity and exported electricity still have a substantial effect on allowable $\$/m^2$. As long as all thermal output can be used on-site (no dumping is required), increasing system sizes bring higher values under California conditions if they imply increasing electricity exports (e.g., SIC 3711, system sizes from 25000 to 100000 m^2). When electricity exports are <u>not</u> increased, system values hold constant with increasing size if no thermal energy is dumped (e.g., SIC 3711, 200 m^2 to 25000 m^2; SIC 2869, system sizes from 200 m^2 to 10000 m^2. Under Arizona assumptions, where exported electricity is less valuable than on-site displacement, an increasing proportion of exported electricity decreases systemvalue (refer to Arizona values for the same cases).

- Under either set of assumptions on relative electricity values, system sizes substantially in excess of on-site thermal demand lead to declines in system value in $\$/m^2$. The values for SIC 3479, with its low T/E ratio, fall steadily throughout the range of system sizes studied because on-site thermal demand is rapidly exceeded, and the increments in PDS thermal output have no economic value. (Contrast this with SIC 3711, where allowable $\$/m^2$ is constant from 200 to 25000 m^2.) SIC 2869 has a very high T/E ratio (13.0), and on-site thermal demand is never exceeded across the range of system sizes studied. (The decline in $\$/m^2$ experienced for Arizona is the lower-value export effort mentioned above. California values increase throughout the size range.)

- The major effect of discount rate on value remains. As in Table 3.1, values under a 25% discount rate run only about half those for a 15% discount rate.

TABLE 3.7 ALLOWABLE INSTALLED COSTS ($\$/m^2$ system) FOR DISH COGENERATION SYSTEMS FOR VARIOUS SYSTEM SIZES IN ARIZONA AND CALIFORNIA, FOR SELECTED DISCOUNT RATES

Industry	PDS System Sizes Evaluated	ARIZONA			CALIFORNIA		
		R = 15%	R = 20%	R = 25%	R = 15%	R = 20%	R = 25%
Metal Coating SIC 3479	200 m^2	437.60	301.28	217.13	490.37	337.60	243.29
	1000 m^2	414.84	285.94	206.28	483.92	333.26	240.23
	2500 m^2	298.68	206.84	149.82	408.86	283.24	205.22
	5000 m^2	250.79	174.20	126.51	379.59	263.83	191.70
	25000 m^2	208.91	145.66	106.11	262.22	182.81	133.17
Fluid Milk SIC 2026	200 m^2	437.60	301.28	217.13	490.37	337.60	243.29
	2500 m^2	408.48	281.26	202.71	494.80	340.73	245.59
	5000 m^2	315.73	218.21	157.78	436.02	304.50	220.29
	15000 m^2	240.27	166.94	121.25	381.62	265.34	192.85
	25000 m^2	223.54	155.57	113.16	368.09	256.31	186.52
Motor Vehicles SIC 3711	200 m^2	437.60	301.28	217.13	490.37	337.60	243.29
	25000 m^2	437.56	301.26	217.11	490.33	337.58	243.27
	50000 m^2	418.46	287.93	207.39	497.59	342.64	246.97
	100000 m^2	390.53	268.52	193.29	514.54	354.47	255.59
Bread, Cake SIC 2869	200 m^2	437.60	301.28	217.13	490.37	337.60	243.29
	1000 m^2	421.62	290.13	209.00	495.68	341.31	246.00
	2500 m^2	390.24	268.24	193.03	517.19	356.32	256.94
	5000 m^2	327.50	225.98	163.17	475.11	328.22	237.24
	15000 m^2	241.11	167.34	121.44	395.34	274.69	199.53
	25000 m^2	224.07	155.83	113.28	376.69	262.17	190.71

25000 m	224.07	155.83	113.28	376.69	262.17	190.71

TABLE 3.7 ALLOWABLE INSTALLED COSTS ($\$/m^2$ system) FOR DISH COGENERATION SYSTEMS FOR VARIOUS SYSTEM SIZES IN ARIZONA AND CALIFORNIA, FOR SELECTED DISCOUNT RATES (cont)

Industry		ARIZONA			CALIFORNIA		
	PDS System Sizes Evaluated	R = 15%	R = 20%	R = 25%	R = 15%	R = 20%	R = 25%
Industrial Organic Chemicals SIC 2869	200 m^2	437.60	301.28	217.13	490.37	338.60	243.29
	5000 m^2	437.60	301.28	217.13	490.41	337.63	243.31
	10000 m^2	431.76	297.21	214.15	490.40	337.62	243.31
	15000 m^2	413.31	284.33	204.76	500.71	344.82	248.55
	25000 m^2	396.12	272.33	196.01	504.39	347.61	250.72

3.2.3 Producing Synthetic Demand Curves from the Value Results

The size-dependent results on PDS system value are based, for each state-industry combination, on the on-site thermal and electric demands for a "typical" plant. These typical plants, described in this study only by their yearly energy consumption levels and instantaneous demands for thermal and electric energy, were derived in Tables 3.3 and 3.4. Energy consumption for the typical plant is found as one "nth" of the energy consumption by that SIC within the service territory. Thus, the correct process for going to service-territory-level demand curves from plant-level value curves is simply to multiply the system sizes of Table 3.7 by the appropriate values of n. These values, taken from Table 3.3, are repeated in Table 3.8.

To call the results of these calculation PDS demand curves is to use the term "demand curve" in a very restricted sense. If all the necessary assumptions to arrive at plant-level energy demands and PDS performance are valid, and if the energy prices used are representative of those relevant to the adopt/not adopt decision in each of the industries studied, then the value coordinates of Table 3.8 represent the maximum amounts that could be paid for installed systems without their costs exceeding their values. Whether these amounts would be paid depends on factors outside of the scope of this study. Some examples of such factors are:

- What are the general attitudes towards investment, particularly investment that does not increase production capacity, in the specific industries studied?
- How well do the assumed energy futures used in this study correspond to the decision attitudes of the industries studied?
- To what extent does user ownership correspond to the PDS implementation structures most likely to be used?
- To what extent do the energy savings measured by this study overstate the true incremental benefits of PDS systems by failing to reflect energy savings that will be forthcoming in any case (i.e., to what extent are 1976 energy use date overstatements of 1985 energy use)?

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TABLE 3.8 ADJUSTMENT SCALARS TO PRODUCE PDS DEMAND AT THE SERVICE TERRITORY LEVEL FROM THE PLANT-LEVEL VALUE CURVES OF TABLE 3.7

Industry	Arizona Public Service	Southern California Edison
Metal Coating SIC 3479	11	213
Fluid Milk SIC 2026	10	103
Motor Vehicles SIC 3711	1	45
Bread, Cake SIC 2051	20	127
Industrial Organic Chemicals SIC 2869	2	38

- How likely are the system sizes which imply that large fractions of on-site energy demands will be provided by solar energy?

The cumulative effect of these reservations is to suggest that the value results above are only roughly indicative of the potential demands for PDS technology. Within the limitations of the aggregate data used for the study, they usefully illustrate the effects on PDS economics of the relative values of displaced and exported electricity, and the penalty imposed when PDS thermal output cannot be gainfully used. They do not incorporate enough of the complexities of site-specific conditions or of the adoption decision process to predict the extent to which the PDS energy option will be exercised.

3.3 CONCLUSIONS

Behind all the results above on the value of parabolic dish solar thermal systems in cogeneration applications is one central programmatic question: Does the cogeneration application represent a market with higher breakeven module values than the electricity-alone options? Based on the above results, it is difficult to be optimistic that cogeneration opens a whole new vista of marketing opportunities. There are several factors inducing this conservatism:

- As shown above, the extra contribution to system value from utility sell-back as opposed to on-site use of electricity is a second-order effect, and can easily be negative. Only in cases where the sell-back rate is substantially in excess of the value of displaced power will the PURPA sell back provision make the cogeneration configuration of a system a major contributor to allowable cost. It should be noted that to the extent that high sell-back rates reflect high true avoided cost, many generating technologies will have higher allowable costs to the corresponding utilities. If the consumer is made to confront high marginal generating costs through rate redesign or higher demand charges, the avoided cost provisions of PURPA relating to cogenerators will constitute no special advantage.

- The substantive (as opposed to regulatory) source of higher values for cogenerating systems comes, of course, from the useful application of thermal energy that would otherwise be thrown away. Obviously this increases gross system value. Whether it increases allowable module cost depends on the value of thermal energy displaced compared to the incremental cost of modifying the dish energy system to collect and deliver heat from the exhaust stream of the electrical generating subsystem. Thermal energy displacement contributed a substantial share of allowable system cost in all cases (ranging from 23.9 to 28.1%). The interesting question, beyond the scope of this study, is how much of this dividend is left after paying for the thermal transport subsystem and waste heat boiler necessary to convert Brayton exhaust into usable steam.

- Although the demand charge analysis was hardly rigorous, it at least gave an indication of the importance of reducing power demand (maximum ordinate of the kW_e demanded vs. time curve) as well as energy consumed (area under the power vs. time curve).

  For the cases considered above, the demand charge adjustment was a more important contributor to allowable cost than export revenues in every case. Clearly this result can be shifted with different assumptions about system sizing, reduction in peak demand, utility buy-back rates, etc. There are two points

to be made with respect to this finding. First, for at least one set of reasonable values for the relevant parameters, the export effects on system value are dominated by peak demand reduction effects. Second, the benefits to be gained from reduction in peak demand are in no way unique to solar cogeneration, but are available to a whole range of technologies. Some of these, such as conservation and load management, may not actually produce energy at all.

There are two elements missing in the present study that are essential to any definitive determination of the market opportunity presented to parabolic dish solar thermal systems by the cogeneration application. The first is a more detailed specification of energy end-use requirements for the industries targeted as markets. This study assumed that all energy output by the system could be used, and should therefore be credited at full value. Given the modular nature of dish systems, this is probably a good assumption (i.e., it is probably possible to size the solar facility such that neither electric nor thermal energy ever has to be thrown away). The degree to which electric output from the cogeneration system reduces peak electric demand, without detailed information on in-plant energy use, can only be a guess. Given that the demand charge effects on allowable cost appear to be at least as important as the electricity sell-back effects, this plant-specific information becomes an important determinant of market potential.

The second essential element to determining the marketing advantages of putting dish systems into cogenerating configurations is the incremental cost/incremental benefit comparison on the additional thermal subsystems required. (Since the proportions of thermal and electric energy produced can be changed by system design, it may be appropriate to reoptimize the entire system.) The design tradeoff analyses that led to JPL's decision to prefer focal point conversion for electric-only systems should offer some useful information in this regard.

Given the limitations of the present "overview" study, it is not possible to say that there are no highly promising cogeneration applications for dish systems. It is possible to say that the ability to sell power back to the utility does not, given reasonable present estimates of the sell-back rates, result in dramatic increases in allowable system cost. If highly attractive cogenerating opportunities do exist, they are more likely to be due to technical circumstances whereby the value of cogenerated thermal energy substantially exceeds the cost of capturing it.

Such circumstances might include, for example, situations where the Brayton exhaust flow could be used directly, very close to the dish system, to avoid requirements for a waste heat boiler or extensive pumping of low specific heat air.

APPENDIX A

This appendix contains the 1976 monthly average insolation levels by hour for Barstow, CA, and the seasonal averages computed from them for use in this study (Tables A-1 and A-2). Tables are given for the Spring/Fall and Summer seasons only. Data for the Winter season is in Section 2.0 of the main text.

The appendix also contains hourly profiles of gross system power levels and energy produced. Prior to performing the value analysis, these were adjusted to net usable power/energy amounts by the procedure discussed in Section 2.0. As before, the data for the Winter season are given in that section, and are not given here.

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TABLE A-1

JPL COGENERATION STUDY

Baseline (Barstow) Insolation Profile

Season Spg/Fall (Mar-May; Sept-Nov) (183 days)

Hour	Direct Normal Insolation in kW/m^2							
	March	April	May	Sept	Oct	Nov	Seasonal Average Insolation	Total Incid- Energy kWh_t/m^2
0500	0	0	0.060	0	0	0	0.010	0.077
0600	0.035	0.250	0.440	0.050	0.080	0	0.143	0.297
0700	0.450	0.535	0.630	0.300	0.445	0.345	0.451	0.535
0800	0.630	0.710	0.715	0.445	0.625	0.590	0.619	0.654
0900	0.700	0.770	0.770	0.530	0.700	0.660	0.688	0.718
1000	0.780	0.780	0.800	0.560	0.835	0.730	0.748	0.744
1100	0.795	0.780	0.800	0.510	0.820	0.730	0.739	0.730
1200	0.735	0.780	0.780	0.465	0.835	0.730	0.721	0.710
1300	0.760	0.750	0.780	0.410	0.765	0.730	0.699	0.684
1400	0.725	0.710	0.770	0.375	0.750	0.675	0.663	0.639
1500	0.660	0.670	0.750	0.330	0.660	0.590	0.610	0.562
1600	0.585	0.590	0.690	0.330	0.500	0.390	0.514	0.396
1700	0.365	0.450	0.535	0.200	0.110	0	0.277	0.169
1800	0.017	0.085	0.265	0	0	0	0.061	0.031
1900	0	0	0	0	0	0	0	
2000	0	0	0	0	0	0	0	
								$\sum = 6.943$
								x 183 = [illegible]

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TABLE A-2

JPL COGENERATION STUDY

Baseline (Barstow) Insolation Profile

Season Summer (Jun-Aug) (92 days)

Hour	Direct Normal Insolation in kW/m² June	July	Aug				Seasonal Average Insolation	Total Incident Energy kWh_t/m^2
0500	0.210	0.070	0				0.093	0.047+ 0.286
0600	0.575	0.415	0.445				0.478	0.567
0700	0.735	0.580	0.650				0.655	0.697
0800	0.765	0.690	0.760				0.738	0.746
0900	0.810	0.730	0.720				0.753	0.775
1000	0.810	0.745	0.835				0.797	0.797
1100	0.810	0.745	0.835				0.797	0.805
1200	0.810	0.780	0.850				0.813	0.782
1300	0.810	0.720	0.720				0.750	0.745
1400	0.785	0.645	0.790				0.740	0.722
1500	0.785	0.565	0.760				0.703	0.678
1600	0.720	0.550	0.690				0.653	0.611
1700	0.620	0.510	0.575				0.568	0.448
1800	0.440	0.290	0.250				0.327	0.169
1900	0.015	0.015	0				0.010	0.005
2000	0	0	0				0	
								$\sum = 8.875$
								x 92 = 816.5

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TABLE A-3

JPL COGENERATION STUDY

Baseline (Barstow) Power/Energy Profile

Season Spg/Fall (Mar-May; Sept-Nov) (183 days)

Hour	Seasonal Average Insolation	Thermal Power Level kW_t/m^2	Gross Thermal Energy Produced kWh_t/m^2	Electric Power Level kW_e/m^2	Gross Electric Energy Produced kWh_e/m^2
0500	0.010	0		0	
					0
0600	0.143	0		0	
			0.106		0.051
0700	0.451	0.211		0.102	
			0.252		0.136
0800	0.619	0.293		0.169	
			0.311		0.182
0900	0.688	0.328		0.195	
			0.347		0.203
1000	0.748	0.365		0.211	
			0.362		0.210
1100	0.739	0.359		0.209	
			0.353		0.207
1200	0.721	0.347		0.205	
			0.341		0.202
1300	0.699	0.335		0.199	
			0.326		0.194
1400	0.668	0.317		0.189	
			0.303		0.177
1500	0.610	0.289		0.165	
			0.267		0.144
1600	0.514	0.244		0.123	
			0.183		0.089
1700	0.277	0.121		0.054	
			0.061		0.027
1800	0.061	0		0	
			0		0
1900	0	0		0	
			0		0
2000	0	0		0	
			$\sum$=3.209		$\sum$=1.821
			x183=587.2		x183=333.2

TABLE A-4

JPL COGENERATION STUDY

Baseline (Barstow) Power/Energy Profile

Season Summer (Jun-Aug) (92 days)

Hour	Seasonal Average Insolation	Thermal Power Level kW_t/m^2	Gross Thermal Energy Produced kWh_t/m^2	Electric Power Level kW_e/m^2	Gross Electric Energy Produced kWh_e/m^2
0500	0.093	0	0.113	0	0.055
0600	0.478	0.226	0.268	0.110	0.147
0700	0.655	0.310	0.334	0.184	0.197
0800	0.738	0.358	0.363	0.209	0.211
0900	0.753	0.368	0.383	0.212	0.216
1000	0.797	0.397	0.397	0.219	0.219
1100	0.797	0.397	0.402	0.219	0.221
1200	0.813	0.407	0.387	0.222	0.217
1300	0.750	0.366	0.363	0.211	0.210
1400	0.740	0.350	0.349	0.209	0.205
1500	0.703	0.337	0.323	0.200	0.192
1600	0.653	0.309	0.290	0.183	0.165
1700	0.568	0.270	0.207	0.146	0.109
1800	0.327	0.144	0.072	0.071	0.036
1900	0.010	0	0	0	0
2000	0	0		0	
			$\sum = 4.249$		$\sum = 2.395$
			x92=390.9		x92=220.3

APPENDIX B

This appendix contains the detailed worksheets used to calculate:

- Export electricity under Barstow conditions for the 10 percent and 20 percent peak margin system sizes.
- System breakeven values for the given fuel displacements and prices, over a range of discount rates.

The export electricity calculations can be better understood with reference to the following diagram, Figure B-1. (The scale of Figure B-1 has been exaggerated to illustrate the calculation procedure.) If the dashed horizontal line LC-RC represents a constant on-site electrical load, the amount of energy exported is represented by that portion of the area under the power level curve that lies above LC-RC. Since the total area under the curve is known, we can find the area sought by calculating the area below LC-RC and subtracting from the known total area. LAX and LBX represent consecutive hours whose calculated power levels are LA and LB respectively. The power level LC, equal to on-site electric demand, is reached between the hours LAX and LBX. If we assume that power level increases at a constant rate between LAX and LBX, we can find LCX, the hour at which power level LC is reached, by linear interpolation. Once LCX and its mirror image RCX are found, the calculation of the area of that part of the curve below LC-RC is straightforward. The areas of rectangle LCX-LC-RC-RCX and trapezoids LAX-LA-LC-LCX and RCX-RC-RB-RBX are found by the appropriate formulae. Total energy production in the "tails" of Figure B-1 (i.e. energy produced prior to LAX and after RBX) is added to the sum of those areas. This total represents the "excluded area" (i.e., that portion of the total area under the curve below LC-RC) sought. When the excluded area is subtracted from the total area, the remainder is the amount of exported electric energy.

The worksheets for the COGEN model, and associated Value Analysis Results pages, document the inputs and outputs of the value analysis. They are self-explanatory.

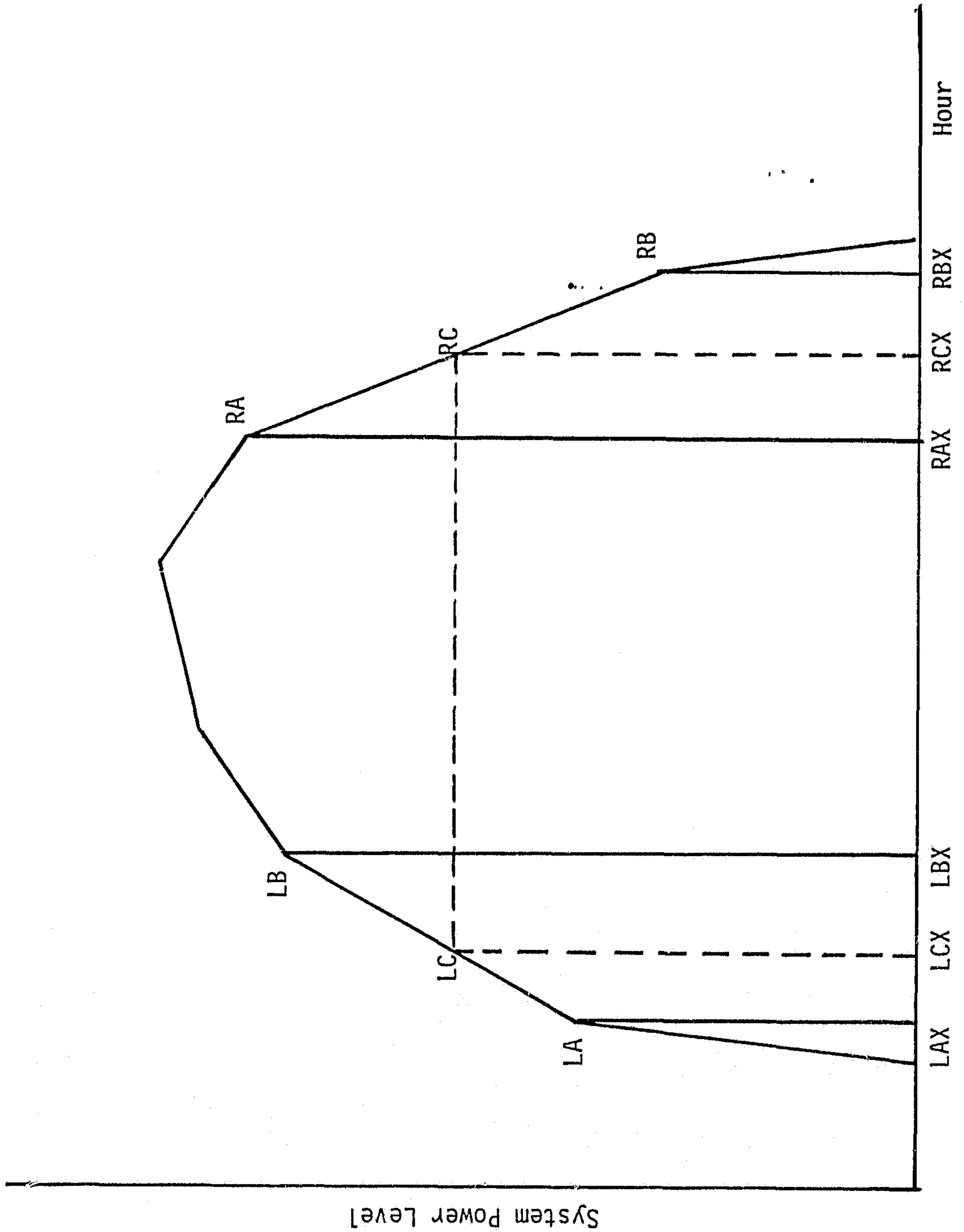

Figure B-1. Export Power Calculation Procedure

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10% Peak Margin

Barstow Conditions

JPL COGENERATION STUDY
EXPORT ELECTRICITY CALCULATION WORKSHEET

Industry Electric Load (CY) = 0.182 kW_e/m^2

...ter Total Area = 1.529 kWh_e/m^2 ;

...t 'shoulder' LAX = 8 LBX = 9 LCX = 9.000 Left Area = 0.157

LAY = 0.132 LBY = 0.182

...nt 'shoulder' RAX = 13 RBX = 14 RCX = 13.923 Right Area = 0.014

RAY = 0.194 RBY = 0.181

0.896 = 0.182 (13.923 - 9.000)

...tangle Area = CY (RCX - LCX)

...as in tails = 0.066 + 0.166 + 0.122 + 0.046 = 0.400

1.467 = 0.157 + 0.014 + 0.896 + 0.400

...luded Area = Left Area + Right Area + Rectangle Area + Areas in Tails

0.062 = 1.529 - 1.467

...ort Area = Total Area - Excluded Area

10% Peak Margin

Barstow

JPL COGENERATION STUDY
EXPORT ELECTRICITY CALCULATION WORKSHEET

Industry Electric Load (CY) = 0.182 kW_e/m^2

...ring/Fall Total Area = 1.643 kWh_e/m^2 ;

...t 'shoulder' LAX = 9 LBX = 10 LCX = 9.429 Left Area = 0.077

LAY = 0.176 LBY = 0.190

...ht 'shoulder' RAX = 12 RBX = 13 RCX = 12.500 Right Area = 0.090

RAY = 0.185 RBY = 0.179

0.559 = 0.182 (12.500 - 9.429)

...tangle Area = CY (RCX - LCX)

...as in tails = 0.046+0.122+0.164+0.175+0.160+0.130+0.080+0.025 = 0.902

1.628 = 0.077 + 0.090 + 0.559 + 0.902

...luded Area = Left Area + Right Area + Rectangle Area + Areas in Tails

0.015 = 1.643 - 1.628

...ort Area = Total Area - Excluded Area

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JPL COGENERATION STUDY
EXPORT ELECTRICITY CALCULATION WORKSHEET

Industry Electric Load (CY) = $0.182\ kW_e/m^2$

Summer Total Area = 2.159 kWh_e/m^2 ;

Left 'shoulder' LAX = 7 LBX = 8 LCX = 7.727 Left Area = 0.127
LAY = 0.166 LBY = 0.188

Right 'shoulder' RAX = 14 RBX = 15 RCX = 14.750 Right Area = 0.045
RAY = 0.188 RBY = 0.180

1.278 = 0.182 (14.750 - 7.727)
Rectangle Area = CY (RCX - LCX)

Areas in tails = 0.050+0.133+0.173+0.148+0.098+0.032 = 0.634

2.084 = 0.127 + 0.045 + 1.278 + 0.634
Excluded Area = Left Area + Right Area + Rectangle Area + Areas in Tails

0.075 = 2.159 - 2.084
Export Area = Total Area - Excluded Area

Yearly Electricity Exports = 90(0.062)+183(0.015)+92(0.075)=15.23

Yearly Displaced Electricity = 90(1.529)+183(1.643)+92(2.159)-15.23=621.7

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25% Peak Margin

Barstow Conditions

JPL COGENERATION STUDY
EXPORT ELECTRICITY CALCULATION WORKSHEET

Industry Electric Load (CY) = 0.160 kW_e/m^2

...ter Total Area = 1.529 kWh_e/m^2 ;

... 'shoulder' LAX = 8 LBX = 9 LCX = 8.560 Left Area = 0.082
LAY = 0.132 LBY = 0.182

...t 'shoulder' RAX = 14 RBX = 15 RCX = 14.700 Right Area = 0.047
RAY = 0.181 RBY = 0.151

0.982 = ____ (14.700 - 8.560)
...angle Area CY (RCX - LCX)

...s in tails = 0.066+0.122+0.046 = 0.234

1.345 = 0.082 + 0.047 + 0.982 + 0.234
...uded Area = Left Area + Right Area + Rectangle Area + Areas in Tails

0.186 = 1.529 - 1.345
...rt Area = Total Area - Excluded Area

25% Peak Margin

Barstow Conditions

JPL COGENERATION STUDY
EXPORT ELECTRICITY CALCULATION WORKSHEET

Industry Electric Load (CY) = 0.160 kW_e/m^2

...ng/Fall Total Area = 1.643 kWh_e/m^2 ;

... 'shoulder' LAX = 8 LBX = 9 LCX = 8.333 Left Area = 0.052
LAY = 0.152 LBY = 0.176

... 'shoulder' RAX = 14 RBX = 15 RCX = 14.476 Right Area = 0.081
RAY = 0.170 RBY = 0.149

.983 = 0.160 (14.476 - 8.333)
...ngle Area CY (RCX - LCX)

... in tails = 0.046+0.122+0.130+0.080+0.025 = 0.403

1.519 = 0.052 + 0.081 + 0.983 + 0.403
...ded Area = Left Area + Right Area + Rectangle Area + Areas in Tails

.124 = 1.643 - 1.519
... Area = Total Area - Excluded Area

Barstow Conditions

JPL COGENERATION STUDY
EXPORT ELECTRICITY CALCULATION WORKSHEET

Industry Electric Load (CY) = 0.160 kW_e/m^2

Summer Total Area = 2.159 kWh_e/m^2 ;

Left 'shoulder' LAX = 6 LBX = 7 LCX = 6.910 Left Area = 0.118
LAY = 0.099 LBY = 0.166

Right 'shoulder' RAX = 16 RBX = 17 RCX = 16.147 Right Area = 0.124
RAY = 0.165 RBY = 0.131

1.478 = 0.160 (16.147 - 6.910)
Rectangle Area = CY (RCX - LCX)

Areas in tails = 0.050+0.098+0.032 = 0.180

1.900 = 0.118 + 0.124 + 1.478 + 0.180
Excluded Area = Left Area + Right Area + Rectangle Area + Areas in Tails

0.259 = 2.159 - 1.900
Export Area = Total Area - Excluded Area

Yearly Electricity Exports = 90(0.186)+183(0.124)+92(0.259) = 63.26

Displaced Electricity = 90(1.529)+183(1.643)+92(2.159)-63.26 = 573.6

Service Territory/Case ______
Name of This Run ______
Date / /

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JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL

OPERATING DATA

FUEL 1
Description: Natural Gas

Amount Displaced(Used) Annually: 3.26 MBtu/m^2

Price in Base Year: \$2.33/MBtu

ESCFL1	0.15	R(10)
\$FL1	7.60	R(11)

FUEL 2
Description: Displaced Electricity

Amount Displaced(Used) Annually: 605.1 kWh_e/m^2

Price in Base Year: \$0.0406

ESCFL2	0.12	R(12)
\$FL2	24.57	R(13)

FUEL 3
Description: Exported Electricity

Amount Displaced(Used) Annually: None - zero margin case

Price in Base Year:

ESCFL3	0.12	R(14)
\$FL3	-0-	R(15)

FUEL 4
Description: Demand Charge Adjustment

Amount Displaced(Used) Annually: 0.05kW_e/m^2 reduction in peak demand each month ⇒ (0.05)(115)(0.0406)(12) = \$2.80/m^2

Price in Base Year:

ESCFL4	0.12	R(16)
\$FL4	2.80	R(17)

Name of This Run ____________

Date / /

JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL(continued)

OPERATING DATA(continued)

OPERATING COSTS

Description: Operating costs assumed to be 2% of installed capital costs and to escalate at 10% per year (same as general inflation).

Assumptions:

XOP	0.02	R(20)
ESCXOP	0.10	R(21)

NOTES ON THIS RUN:

Natural Gas Displacement (from Table 2.5) is 3.434 $MBtu/m^2$

Under Barstow conditions

Adjusted to APS: 3.434 (0.95) = 3.26 $MBtu/m^2$

Value of first year displacement at \$2.33/MBtu = \$7.60/m^2

Displaced Electricity

Under 0% margin case, all electricity production results in displacement. Thus, displaced electricity is 636.9 kWh_e/m^2 under Barstow conditions.

Adjusted to APS: 605.1

Value of first year displacement at \$0.0406/kWh_e = \$24.57/m^2

Demand Charge Adjustment

Arbitrarily assume that this system reduces monthly peak demand by 0.05 kWh_e/m^2. At (115)(0.0406) per kW_e reduction per month, this is worth \$2.80/m^2 in the first year.

Service Territory/Case APS/0% Margin

JPL COGENERATION STUDY: VALUE ANALYSIS RESULTS

Interest Rates	Present Values of Displaced Fuels ($/m^2)					Allowable Installed Cost ($/m^2, system)	Allowable f.o.b. Factory Cost ($/m^2, module)
	Natural Gas	Displaced Electricity	Export Electricity	Demand Charge	ΣPVFL		
R = 0.100 FCR = 0.1278 CRF = 0.1175	250.45	596.96	-0-	68.03	915.44	615.24	431.77
R = 0.150 FCR = 0.1809 CRF = 0.1598	152.00	376.64	-0-	42.92	571.57	410.69	271.27
R = 0.200 FCR = 0.2427 CRF = 0.2054	100.18	257.43	-0-	29.34	386.94	283.79	171.69
R = 0.250 FCR = 0.3112 CRF = 0.2529	70.91	188.14	-0-	21.44	280.49	205.38	110.15

Name of This Run ______

Date 11/09/81

JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL

OPERATING DATA

FUEL 1
Description: Natural Gas

Amount Displaced(Used) Annually: 3.26 $MBtu/m^2$

Price in Base Year: $2.33/MBtu

ESCFL1 ____0.15____ R(10)

$FL1 ____$7.60____ R(11)

FUEL 2
Description: Displaced Electricity

Amount Displaced(Used) Annually: 590.6 kWh_e/m^2

Price in Base Year: $0.0406/$kWh_e$

ESCFL2 ____0.12____ R(12)

$FL2 ____$23.98____ R(13)

FUEL 3
Description: Exported Electricity

Amount Displaced(Used) Annually: 14.47 kWh_e/m^2

Price in Base Year: $0.02978/$kWh_e$

ESCFL3 ____0.12____ R(14)

$FL3 ____$0.43____ R(15)

FUEL 4
Description: Demand Charge Adjustment

Amount Displaced(Used) Annually: 0.07 kW_e/m^2 reduction in peak demand is worth 0.07 (115) (0.0406) = $0.327/month, or $3.92/$m^2$ per year

Price in Base Year:

ESCFL4 ____0.12____ R(16)

$FL4 ____$3.92____ R(17)

Name of This Run ____________

Date 11/09/81

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JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL(continued)

OPERATING DATA(continued)

OPERATING COSTS

Description: Assumed to be 2% of installed capital cost, escalate at 10%

Assumptions:

XOP	0.02	R(20)
ESCXOP	0.10	R(21)

NOTES ON THIS RUN:

Natural Gas Displacement (from Table 2.5) is 3.434 $MBtu/m^2$

Under Barstow conditions

Adjusted to APS: 3.434 (0.95) = 3.26 $MBtu/m^2$

Value of first-year displacement at \$2.33/MBtu = \$7.60/m^2

Displaced Electricity

For the 10% margin cases, 621.7 kWh_e/m^2 are displaced at Barstow

Adjusted to APS: 621.7 (0.95) = 590.6

Value of first-year displacement at \$0.0406/kWh_e = \$23.98/m^2

Exported Electricity

For the 10% margin cases, 15.23 kWh_e/m^2 are exported at Barstow

Adjusted to APS: 15.23 (0.95) = 14.47

Value of first-year exports at \$0.02978/kWh_e = \$0.43/m^2

Demand Charge Adjustment

Arbitrarily assume this system reduces monthly peak demand by 0.07 kW_e/m^2. At (115) (0.0406) per kW_e per month, this is worth \$3.92/m^2 in the first year.

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JPL COGENERATION STUDY: VALUE ANALYSIS RESULTS

Interest Rates	Present Values of Displaced Fuels ($/m^2)					Allowable Installed Cost ($/m^2, system)	Allowable f.o.b. Factory Cost ($/m^2, module)
	Natural Gas	Displaced Electricity	Export Electricity	Demand Charge	ΣPVFL		
R = 0.100 FCR = 0.1278 CRF = 0.1175	250.45	582.62	10.45	95.24	938.76	630.92	444.07
R = 0.150 FCR = 0.1809 CRF = 0.1598	152.00	367.60	6.59	60.09	586.28	421.27	279.56
R = 0.200 FCR = 0.2427 CRF = 0.2054	100.18	251.25	4.51	41.07	397.00	291.17	177.47
R = 0.250 FCR = 0.3112 CRF = 0.2529	70.91	183.62	3.29	30.02	287.84	210.76	114.38

Name of This Run ______________

Date 11/09/81

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JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL

OPERATING DATA

FUEL 1

Description: Natural Gas

Amount Displaced(Used) Annually: 3.26 $MBtu/m^2$

Price in Base Year: $2.33/MBtu

ESCFL1	0.15	R(10)
$FL1	$7.60	R(11)

FUEL 2

Description: Displaced Electricity

Amount Displaced(Used) Annually: 544.9 kWh_e/m^2

Price in Base Year: $0.0406

ESCFL2	0.12	R(12)
$FL2	$22.12	R(13)

FUEL 3

Description: Exported Electricity

Amount Displaced(Used) Annually: 60.1 kWh_e/m^2

Price in Base Year: $0.02978/$kWh_e$

ESCFL3	0.12	R(14)
$FL3	$1.79	R(15)

FUEL 4

Description: Demand Charge Adjustment

Amount Displaced(Used) Annually: 0.10 kWh_e reduction in peak demand is worth 0.10 (115) (0.0406) = $0.47 per month, and $5.60/$m^2$ per year

Price in Base Year:

ESCFL4	0.12	R(16)
$FL4	$5.60	R(17)

JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL(continued)

OPERATING DATA(continued)

OPERATING COSTS

Description: Assume yearly O&M is 2% of installed capital cost in the first year, escalating at 10%

Assumptions:

XOP	0.02	R(20)
ESCXOP	0.10	R(21)

NOTES ON THIS RUN:

Natural Gas Displacement (from Table 2.5) is 3.434 $MBtu/m^2$

Under Barstow conditions

Adjusted to APS: 3.434 (0.95) = 3.26 $MBtu/m^2$

Value of first-year displacement at \$2.33/MBtu = \$7.60/m^2

Displaced Electricity

Under 25% margin case, 573.6 kWh_e/m^2 are displaced at Barstow.

Adjusted to APS: 573.6 (0.95) = 544.9

Value of first-year displacement at \$0.0406/kWh_e = \$22.12/m^2

Exported Electricity

For the 25% margin case, electricity exports at Barstow are 63.26 kWh_e/m^2

Adjusted to APS: 63.26 (0.95) = 60.1

Value of first-year exports at \$0.02978/kWh_e = \$1.79/m^2

Demand Charge Adjustment

Arbitrarily assume this system reduces monthly peak demand by 0.10 kW_e/m^2. At (115) (0.0406) per kW_e per month, this reduction is worth \$5.60/m^2 in the first year.

JPL COGENERATION STUDY: VALUE ANALYSIS RESULTS

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Interest Rates	Present Values of Displaced Fuels ($\$/m^2$)					Allowable Installed Cost ($\$/m^2$, system)	Allowable f.o.b. Factory Cost ($\$/m^2$, module)
	Natural Gas	Displaced Electricity	Export Electricity	Demand Charge	ΣPVFL		
R = 0.100 FCR = 0.1278 CRF = 0.1175	250.45	537.43	43.49	136.06	967.43	650.19	459.19
R = 0.150 FCR = 0.1809 CRF = 0.1598	152.00	399.09	27.44	85.84	604.37	434.27	289.76
R = 0.200 FCR = 0.2427 CRF = 0.2054	100.18	231.76	18.75	58.67	409.36	300.24	184.59
R = 0.250 FCR = 0.3112 CRF = 0.2529	70.91	169.38	13.71	42.88	296.87	217.37	119.57

Service Territory/Case
Name of This Run SCE/0%
Date / /

JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL

OPERATING DATA

FUEL 1
Description: Natural Gas

Amount Displaced(Used) Annually: 2.75 $MBtu/m^2$

Price in Base Year: $3.11/MBtu

ESCFL1	0.15	R(10)
$FL1	$8.55	R(11)

FUEL 2
Description: Displaced Electricity

Amount Displaced(Used) Annually: 509.5 kWh_e/m^2

Price in Base Year: $0.05382/$kWh_e$

ESCFL2	0.12	R(12)
$FL2	$27.42	R(13)

FUEL 3
Description: Exported Electricity

Amount Displaced(Used) Annually: -0-

Price in Base Year:

ESCFL3		R(14)
$FL3	-0-	R(15)

FUEL 4
Description: Demand Charge Adjustment

Amount Displaced(Used) Annually: Peak demand is assumed reduced by 0.05 kW_e at $3.80 per kW_e. This is a monthly savings of $0.19, or a yearly savings
Price in Base Year: of $2.28/$m^2$

ESCFL4	0.12	R(16)
$FL4	$2.28	R(17)

Service Territory/Case

Name of This Run SCE/0%

Date / /

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JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL(continued)

OPERATING DATA(continued)

OPERATING COSTS
Description:

Assumptions: Annual maintenance is 2 percent of installed capital cost, escalating at 10 percent per year.

XOP	0.02	R(20)
ESCXOP	0.10	R(21)

NOTES ON THIS RUN:

Natural Gas Displacement (from Table 2.5) is 3.434 MBtu/m^2 at Barstow

Adjusted to SCE: 3.434 (0.80) = \$2.75 MBtu/m^2

Value of first year displacement at \$3.11/MBtu = \$8.55/m^2

Displaced Electricity: Under 0% margin sizing assumptions, all the electricity produced goes to displace on-site load. Barstow displacement is 636.9 kWh_e/m^2.

Adjusted to SCE: 636.9 (0.80) = 509.5 kWh_e/m^2

Value of first year savings at \$0.05382/kWh_e = \$27.42/m^2

Demand Charge Adjustment

Arbitrarily assume that this system reduces monthly peak demand by 0.05 kW_e/m^2. At \$45.52/year for each kW_e reduction, this is worth \$2.28/m^2.

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Service Territory 0% Margin/ SCE

JPL COGENERATION STUDY: VALUE ANALYSIS RESULTS

Interest Rates	Present Values of Displaced Fuels ($\$/m^2$)					Allowable Installed Cost ($\$/m^2$, system)	Allowable f.o.b. Factory Cost ($\$/m^2$, module)
	Natural Gas	Displaced Electricity	Export Electricity	Demand Charge	ΣPVFL		
R = 0.100 FCR = 0.1278 CRF = 0.1175	281.76	666.20	-0-	55.40	1003.35	674.33	478.14
R = 0.150 FCR = 0.1809 CRF = 0.1598	171.00	420.33	-0-	34.95	626.28	450.01	302.12
R = 0.200 FCR = 0.2427 CRF = 0.2054	112.70	287.29	-0-	23.89	423.88	310.88	192.94
R = 0.250 FCR = 0.3112 CRF = 0.2529	79.77	209.96	-0-	17.46	307.19	224.93	125.50

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Name of This Run SCE/10%

Date / /

JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL

OPERATING DATA

FUEL 1
Description: Natural Gas

Amount Displaced(Used) Annually: 2.75 $MBtu/m^2$

Price in Base Year: $3.11

ESCFL1	0.15	R(10)
$FL1	$8.55	R(11)

FUEL 2
Description: Displaced Electricity

Amount Displaced(Used) Annually: 497.4 kWh_e/m^2

Price in Base Year: $0.05382/$kWh_e$

ESCFL2	0.12	R(12)
$FL2	$26.77	R(13)

FUEL 3
Description: Exported Electricity

Amount Displaced(Used) Annually: 12.18 kWh_e/m^2

Price in Base Year: $0.062

ESCFL3	0.12	R(14)
$FL3	$0.76/$m^2$	R(15)

FUEL 4
Description: Demand Charge Adjustment

Amount Displaced(Used) Annually: Reduces peak demand by 0.07 kW_e/m^2

Price in Base Year: $45.52 per kW_e reduction per year

ESCFL4	0.12	R(16)
$FL4	$3.19	R(17)

Name of This Run SCE/10%

Date / /

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JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL(continued)

OPERATING DATA(continued)

OPERATING COSTS

Description: Operating costs in first year assumed to be 2% of installed capital cost, and to escalate at 10%.

Assumptions:

XOP	0.02	R(20)
ESCXOP	0.10	R(21)

NOTES ON THIS RUN:

Natural Gas Displacement (from Table 2.5) in 3.434 MBtu/m^2 at Barstow

Adjusted to SCE: 3.434 (0.80) = 2.75 MBtu/m^2

Value of first year savings at \$3.11/MBtu = \$8.55/m^2

Displaced Electricity

Under 10% margin case, 621.7 kWh_e/m^2 are displaced at Barstow

Adjusted to SCE: 621.7 (0.80) = 497.4 kWh_e/m^2

Value of first year displacement at \$0.05382/kWh_e = \$26.77/m^2

Exported Electricity

15.23 kWh_e/m^2 are exported for the 10% margin case at Barstow. Therefore, for SCE, exports are 15.23 (0.80) = 12.18

Value of first year exports at \$0.062/kWh_e = \$0.76/m^2

Demand Charge Adjustment

Assume cogeneration system reduces peak demand by 0.07 kW_e/m^2. At \$45.52/year for each kW_e reduction, this is worth \$3.19/m^2.

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Service Territory 10% Margin/SCE

JPL COGENERATION STUDY: VALUE ANALYSIS RESULTS

Interest Rates	Present Values of Displaced Fuels ($\$/m^2$): Natural Gas	Displaced Electricity	Export Electricity	Demand Charge	ΣPVFL	Allowable Installed Cost ($\$/m^2$, system)	Allowable f.o.b. Factory Cost ($\$/m^2$, module)
R = 0.100 FCR = 0.1278 CRF = 0.1175	281.76	650.41	18.47	77.50	1028.13	690.99	491.20
R = 0.150 FCR = 0.1809 CRF = 0.1598	171.00	410.37	11.65	48.90	641.92	461.25	310.93
R = 0.200 FCR = 0.2427 CRF = 0.2054	112.70	280.48	7.96	33.42	434.56	318.72	199.09
R = 0.250 FCR = 0.3112 CRF = 0.2529	79.77	204.98	5.82	24.43	315.00	230.65	129.99

Name of This Run SCE/25%

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Date / /

JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL

OPERATING DATA

FUEL 1
Description: Natural Gas

Amount Displaced(Used) Annually: 2.75 MBtu/m^2

Price in Base Year: $3.11

ESCFL1 0.15 R(10)

$FL1 $8.55 R(11)

FUEL 2
Description: Displaced Electricity

Amount Displaced(Used) Annually: 458.9 kWh_e/m^2

Price in Base Year: $0.05382/$kWh_e$

ESCFL2 0.12 R(12)

$FL2 $24.70 R(13)

FUEL 3
Description: Exported Electricity

Amount Displaced(Used) Annually: 50.6 kWh_e/m^2

Price in Base Year: $0.062/$kWh_e$

ESCFL3 0.12 R(14)

$FL3 $3.14 R(15)

FUEL 4
Description: Demand Charge Adjustment

Amount Displaced(Used) Annually: Reduces peak demand by 0.10 kW_e/m^2

Price in Base Year: $45.52 per kW_e reduction per year

ESCFL4 0.12 R(16)

$FL4 $4.55 R(17)

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Service Territory/Case ____

Name of This Run SCE/25%

Date / /

JPL COGENERATION STUDY

WORKSHEET FOR 'COGEN' MODEL(continued)

OPERATING DATA(continued)

OPERATING COSTS

Description: Operating costs in first year assumed to be 2% of installed capital cost, and to escalate at 10%

Assumptions:

XOP	0.02	R(20)
ESCXOP	0.10	R(21)

NOTES ON THIS RUN:

Natural Gas Displacement (from Table 2.5) is 3.434 $MBtu/m^2$

Under Barstow conditions

Adjusted to SCE: 3.434 (0.80) = 2.75 $MBtu/m^2$

Value of first year savings at \$3.11/MBtu = \$8.55m^2

Displaced Electricity

Under the 25% margin case, electricity displacement at Barstow is 573.6 kWh_e/m^2.

Adjusted to SCE: 573.6 (0.80) = 458.9 kWh_e/m^2

Value of first year displacement at \$0.05382/kWh_e = \$24.70/m^2

Exported Electricity

For the 25% margin case at Barstow, electricity exports are 63.26 kWh_e/m^2

Adjusted to SCE: 63.26 (0.80) = 50.6 kWh_e/m^2

Value of first year exports at \$0.062/kWh_e = \$3.14/m^2

Demand Charge Adjustment

Assume cogeneration system reduces peak demand by 0.10 kW_e at \$45.52/year for each kW_e reduction. This is worth \$4.55/m^2.

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Service Territory 25% Margin/SCE

JPL COGENERATION STUDY: VALUE ANALYSIS RESULTS

Interest Rates	Present Values of Displaced Fuels ($/m^2)					Allowable Installed Cost ($/m^2, system)	Allowable f.o.b. Factory Cost ($/m^2, module)
	Natural Gas	Displaced Electricity	Export Electricity	Demand Charge	ΣPVFL		
R = 0.100 FCR = 0.1278 CRF = 0.1175	281.76	600.12	76.29	110.55	1068.71	718.26	512.60
R = 0.150 FCR = 0.1809 CRF = 0.1598	171.00	378.64	48.13	69.75	667.52	479.64	325.37
R = 0.200 FCR = 0.2427 CRF = 0.2054	112.70	258.79	32.90	47.67	452.06	331.55	209.16
R = 0.250 FCR = 0.3112 CRF = 0.2529	79.77	189.13	24.04	34.84	327.79	240.01	137.33

APPENDIX C

This appendix contains the HP-41C output for all the simulations of daily fuel savings by system size (S), industry, and location. The most relevant parts of this information are treated in the main text. The detailed results are presented here for those who wich more detail on the origins of the yearly totals. Specifically, this is the only record of the physical amounts energy produced and dumped.

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Metal Coating SIC 3479
CA Winter

CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP
3479W	3479W	3479W	3479W	3479W
DT=5.670E-1	DT=5.670E-1	DT=5.670E-1	DT=5.670E-1	DT=5.670E-1
DE=1.780E2	DE=1.780E2	DE=1.780E2	DE=1.780E2	DE=1.780E2
S=2.000E2	S=1.000E3	S=2.500E3	S=5.000E3	S=2.500E4
Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0
Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2
Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1
DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1

	Case 1	Case 2	Case 3	Case 4	Case 5
THRML (MBtu/DAY)					
PROD	9.979-01	4.998+00	1.247+01	2.495+01	1.247+02
USED	9.979-01	4.666+00	5.528+00	5.678+00	5.678+00
VAL($)	4.138+00	1.935+01	2.292+01	2.351+01	2.351+01
DUMP	0.000+00	3.236-01	6.946+00	1.928+01	1.191+02
ELEC (kWh/DAY)					
PROD	2.446+02	1.223+03	3.058+03	6.116+03	3.058+04
USED	2.446+02	1.223+03	1.648+03	1.780+03	1.780+03
VAL($)	1.319+01	6.595+01	8.886+01	9.598+01	9.598+01
XPOPT	0.000+00	0.000+00	1.410+03	4.336+03	2.838+04
VAL($)	0.000+00	0.000+00	8.742+01	2.698+02	1.786+03
ΣVAL	17.33	85.30	199.20	383.32	1,985.09
VMSO	7.80	7.68	7.17	6.9[illegible]	6.86

VMSQ 6.99 VMSQ 6.86

Metal Coating SIC 3479
CA Spring/Fall

CASE DESCRIP	3479SF	3479SF	3479SF	3479SF	3479SF
DT=	5.670E-1	5.670E-1	5.670E-1	5.670E-1	5.670E-1
DE=	1.780E2	1.780E2	1.780E2	1.780E2	1.780E2
S=	2.000E2	1.000E3	2.500E3	5.000E3	2.500E4
Pt=	3.110E0	3.110E0	3.110E0	3.110E0	3.110E0
Pe=	5.392E-2	5.392E-2	5.392E-2	5.392E-2	5.392E-2
Px=	6.200E-2	6.200E-2	6.200E-2	6.200E-2	6.200E-2
ETA=	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ=	8.000E-1	8.000E-1	8.000E-1	8.000E-1	8.000E-1
DAYS=	1.830E2	1.830E2	1.830E2	1.830E2	1.830E2
THRML	MBtu/DAY	MBtu/DAY	MBtu/DAY	MBtu/DAY	MBtu/DAY
PROD	1.053+00	5.265+00	1.316+01	2.633+01	1.316+02
USED	1.053+00	5.225+00	6.354+00	6.737+00	6.884+00
VAL($)	4.366+00	2.167+01	2.635+01	2.794+01	2.821+01
DUMP	0.000+00	3.980-02	6.808+00	1.959+01	1.248+02
ELEC	kWh/DAY	kWh/DAY	kWh/DAY	kWh/DAY	kWh/DAY
PROD	2.629+02	1.314+03	3.286+03	6.572+03	3.286+04
USED	2.629+02	1.314+03	1.904+03	2.058+03	2.136+03
VAL($)	1.417+01	7.087+01	1.027+02	1.110+02	1.152+02
XPORT	0.000+00	0.000+00	1.382+03	4.514+03	3.672+04
VAL($)	0.000+00	0.000+00	8.568+01	2.799+02	1.905+03
ΣVAL	18.54	92.54	214.70	412.77	2,048.29
VMSQ	16.96	16.93	15.72	15.33	14.99

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Metal Coating SIC 3479
CA Summer

CASE DESCRIP	3479SM	3479SM	3479SM	3479SM	3479SM
	DT=5.670E-1	DT=5.670E-1	DT=5.670E-1	DT=5.670E-1	DT=5.670E-1
	DE=1.780E2	DE=1.780E2	DE=1.780E2	DE=1.780E2	DE=1.780E2
	S=2.000E2	S=1.000E3	S=2.500E3	S=5.000E3	S=2.500E4
	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0
	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2
	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2
	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1
	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1
THRML (MBtu/DAY)					
PROD	1.394+00	6.968+00	1.742+01	3.484+01	1.742+02
USED	1.394+00	6.603+00	7.562+00	7.938+00	7.938+00
VAL($)	5.779+00	2.739+01	3.136+01	3.292+01	3.292+01
DUMP	0.000+00	3.652-01	9.859+00	2.690+01	1.663+02
ELEC (kWh/DAY)					
PROD	3.454+02	1.727+03	4.318+03	8.636+03	4.318+04
USED	3.454+02	1.727+03	2.300+03	2.442+03	2.492+03
VAL($)	1.863+01	9.313+01	1.240+02	1.317+02	1.344+02
XPORT	0.000+00	0.000+00	2.018+03	6.194+03	4.069+04
VAL($)	0.000+00	0.000+00	1.25[illegible]+02	3.840+02	2.523+03
ΣVAL	24.41	120.51	280.49	548.62	2,689.94
VMSQ	11.23	11.09	10.32	10.09	9.90

Fluid Milk SIC 2026
CA Winter

	Case 1	Case 2	Case 3	Case 4	Case 5
CASE DESCRIP	2026W	2026W	2026W	2026W	2026W
DT	1.560E0	1.560E0	1.560E0	1.560E0	1.560E0
DE	3.050E2	3.050E2	3.050E2	3.050E2	3.050E2
S	2.000E2	2.500E3	5.000E3	1.500E4	2.500E4
Pt	3.110E0	3.110E0	3.110E0	3.110E0	3.110E0
Pe	5.392E-2	5.392E-2	5.392E-2	5.392E-2	5.392E-2
Px	6.200E-2	6.200E-2	6.200E-2	6.200E-2	6.200E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	8.000E-1	8.000E-1	8.000E-1	8.000E-1	8.000E-1
DAYS	9.000E1	9.000E1	9.000E1	9.000E1	9.000E1
THRML (MBtu/DAY)					
PROD	9.979-01	1.247+01	2.495+01	7.484+01	1.247+02
USED	9.979-01	1.225+01	1.446+01	1.560+01	1.560+01
VAL($)	4.138+02	5.079+01	5.998+01	6.469+01	6.469+01
DUMP	0.000+00	2.252-01	1.048+01	5.924+01	1.091+02
ELEC (kWh/DAY)					
PROD	2.446+02	3.058+03	6.116+03	1.835+04	3.058+04
USED	2.446+02	2.603+03	2.888+03	3.050+03	3.050+03
VAL($)	1.319+01	1.404+02	1.557+02	1.645+02	1.645+02
XPORT	0.000+00	4.550+02	3.228+03	1.530+04	2.753+04
VAL($)	0.000+00	2.821+01	2.001+02	9.485+02	1.707+03
ΣVAL	17.33	219.36	415.83	1,177.62	1,936.00
VMSQ	7.80	7.90	7.48	7.07	6.97

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Fluid Milk SIC 2026
CA Spring/Fall

CASE DESCRIP	2026SF	2026SF	2026SF	2026SF	2026SF
DT	1.560E0	1.560E0	1.560E0	1.560E0	1.560E0
DE	3.050E2	3.050E2	3.050E2	3.050E2	3.050E2
S	2.000E2	2.500E3	5.000E3	1.500E4	2.500E4
Pt	3.110E0	3.110E0	3.110E0	3.110E0	3.110E0
Pe	5.392E-2	5.392E-2	5.392E-2	5.392E-2	5.392E-2
Px	6.200E-2	6.200E-2	6.200E-2	6.200E-2	6.200E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	8.000E-1	8.000E-1	8.000E-1	8.000E-1	8.000E-1
DAYS	1.830E2	1.830E2	1.830E2	1.830E2	1.830E2
THRML (MBtu/DAY)					
PROD	1.053+00	1.316+01	2.633+01	7.898+01	1.316+02
USED	1.053+00	1.316+01	1.691+01	1.866+01	1.872+01
VAL($)	4.366+00	5.458+01	7.012+01	7.738+01	7.763+01
DUMP	0.000+00	0.000+00	9.416+00	6.032+01	1.129+02
ELEC (kWh/DAY)					
PROD	2.629+02	3.286+03	6.572+03	1.972+04	3.286+04
USED	2.629+02	2.941+03	3.334+03	3.655+03	3.660+03
VAL($)	1.417+01	1.586+02	1.798+02	1.971+02	1.973+02
XPORT	0.000+00	3.450+02	3.238+03	1.606+04	2.920+04
VAL($)	0.000+00	2.139+01	2.008+02	9.958+02	1.810+03
ΣVAL	18.54	234.55	450.64	1,270.24	2,085.37
VMSO	16.96	17.17	16.49	15.50	15.26

Fluid Milk SIC 2026

Fluid Milk SIC 2026
CA Summer

CASE DESCRIP	2026SM	2026SM	2026SM	2026SM	2026SM
	DT=1.560E0	DT=1.560E0	DT=1.560E0	DT=1.560E0	DT=1.560E0
	DE=3.050E2	DE=3.050E2	DE=3.050E2	DE=3.050E2	DE=3.050E2
	S=2.000E2	S=2.500E3	S=5.000E3	S=1.500E4	S=2.500E4
	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0
	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2
	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2
	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1
	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1
THRML (MBtu/DAY)					
PROD	1.394+00	1.742+01	3.484+01	1.045+02	1.742+02
USED	1.394+00	1.723+01	2.024+01	2.184+01	2.184+01
VAL($)	5.779+00	7.145+01	8.391+01	9.056+01	9.056+01
DUMP	0.000+00	1.900-01	1.461+01	8.268+01	1.524+02
ELEC (kWh/DAY)					
PROD	3.454+02	4.318+03	8.636+03	2.591+04	4.318+04
USED	3.454+02	3.667+03	3.988+03	4.270+03	4.270+03
VAL($)	1.863+01	1.977+02	2.150+02	2.302+02	2.302+02
XPORT	0.000+00	6.510+02	4.648+03	2.164+04	3.891+04
VAL($)	0.000+00	4.036+01	2.882+02	1.342+03	2.412+03
ΣVAL	24.41	309.54	567.12	1,662.36	2,733.22
VMSQ	11.23	11.39	10.80	10.20	10.06

Motor Vehicles SIC 3711
CA Winter

CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	
3711W	3711W	3711W	3711W	
DT=6.950E1	DT=6.950E1	DT=6.950E1	DT=6.950E1	
DE=5.820E3	DE=5.820E3	DE=5.820E3	DE=5.820E3	
S=2.000E2	S=2.500E4	S=5.000E4	S=1.000E5	
Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	
Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	
Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	
ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	
DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	

THRML (MBtu/DAY)				
PROD	9.979-01	1.247+02	2.495+02	4.990+02
USED	9.979-01	1.247+02	2.495+02	4.990+02
VAL($)	4.138+00	5.173+02	1.035+03	2.069+03
DUMP	0.000+00	0.000+00	0.000+00	0.000+00

ELEC (kWh/DAY)				
PROD	2.446+02	3.058+04	6.116+04	1.223+05
USED	2.446+02	3.058+04	5.010+04	5.552+04
VAL($)	1.319+01	1.649+03	2.701+03	2.994+03
XPORT	0.000+00	0.000+00	1.106+04	6.680+04
VAL($)	0.000+00	0.000+00	6.857+02	4.142+03
ΣVAL	17.33	2,166.13	4,421.62	9,204.26
VMSQ	7.80	7.80	7.96	8.28

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Motor Vehicles SIC 3711
CA Spring/Fall

CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP
3711SF	3711SF	3711SF	3711SF
DT=6.950E1	DT=6.950E1	DT=6.950E1	DT=6.950E1
DE=5.820E3	DE=5.820E3	DE=5.820E3	DE=5.820E3
S=2.000E2	S=2.500E4	S=5.000E4	S=1.000E5
Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0
Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2
Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1
DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2
THRML MBtu/DAY	THRML MBtu/DAY	THRML MBtu/DAY	THRML MBtu/DAY
PROD 1.053+00	PROD 1.316+02	PROD 2.633+02	PROD 5.265+02
USED 1.053+00	USED 1.316+02	USED 2.633+02	USED 5.265+02
VAL($) 4.366+00	VAL($) 5.458+02	VAL($) 1.092+03	VAL($) 2.183+03
DUMP 0.000+00	DUMP 0.000+00	DUMP 0.000+00	DUMP 0.000+00
ELEC kWh/DAY	ELEC kWh/DAY	ELEC kWh/DAY	ELEC kWh/DAY
PROD 2.629+02	PROD 3.286+04	PROD 6.572+04	PROD 1.314+05
USED 2.629+02	USED 3.286+04	USED 5.686+04	USED 6.388+04
VAL($) 1.417+01	VAL($) 1.772+03	VAL($) 3.066+03	VAL($) 3.444+03
XPORT 0.000+00	XPORT 0.000+00	XPORT 8.860+03	XPORT 6.756+04
VAL($) 0.000+00	VAL($) 0.000+00	VAL($) 5.493+02	VAL($) 4.189+03
ΣVAL 18.54	ΣVAL 2,317.62	ΣVAL 4,706.83	ΣVAL 9,816.37
VMSO 16.96	VMSO 16.96	VMSO 17.23	VMSO 17.96

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Motor Vehicles SIC 3711
CA Summer

CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP
3711SM	3711SM	3711SM	3711SM
DT=6.950E1	DT=6.950E1	DT=6.950E1	DT=6.950E1
DE=5.820E3	DE=5.820E3	DE=5.820E3	DE=5.820E3
S=2.000E2	S=2.500E4	S=5.000E4	S=1.000E5
Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0
Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2
Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1
DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1

	Case 1	Case 2	Case 3	Case 4
THRML	MBtu/DAY	MBtu/DAY	MBtu/DAY	MBtu/DAY
PROD	1.394+00	1.742+02	3.484+02	6.968+02
USED	1.394+00	1.742+02	3.484+02	6.968+02
VAL($)	5.779+00	7.224+02	1.445+03	2.889+03
DUMP	0.000+00	0.000+00	0.000+00	0.000+00
ELEC	kWh/DAY	kWh/DAY	kWh/DAY	kWh/DAY
PROD	3.454+02	4.318+04	8.636+04	1.727+05
USED	3.454+02	4.318+04	7.072+04	7.640+04
VAL($)	1.863+01	2.328+03	3.813+03	4.119+03
XPORT	0.000+00	0.000+00	1.564+04	9.632+04
VAL($)	0.000+00	0.000+00	9.697+02	5.972+03
ΣVAL	24.41	3,050.64	6,227.65	12,980.82
VMSQ	11.07	11.23	11.46	11.94

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Bread, Cake SIC 2051
CA Winter

CASE DESCRIP	2051W	2051W	2051W	2051W	2051W	2051W
DT	1.920E0	1.920E0	1.920E0	1.920E0	1.920E0	1.920E0
DE	1.250E2	1.250E2	1.250E2	1.250E2	1.250E2	1.250E2
S	2.000E2	1.000E3	2.500E3	5.000E3	1.500E4	2.500E4
Pt	3.110E0	3.110E0	3.110E0	3.110E0	3.110E0	3.110E0
Pe	5.392E-2	5.392E-2	5.392E-2	5.392E-2	5.392E-2	5.392E-2
Px	6.200E-2	6.200E-2	6.200E-2	6.200E-2	6.200E-2	6.200E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-
ADJ	8.000E-1	8.000E-1	8.000E-1	8.000E-1	8.000E-1	8.000E-
DAYS	9.000E1	9.000E1	9.000E1	9.000E1	9.000E1	9.000E
THRML (MBtu/DAY)						
PROD	9.979-01	4.990+00	1.247+01	2.495+01	7.484+01	1.247+02
USED	9.979-01	4.990+00	1.247+01	1.734+01	1.920+01	1.920+01
VAL($)	4.138+00	2.069+01	5.173+01	7.192+01	7.962+01	7.962+01
DUMP	0.000+00	0.000+00	0.000+00	7.604+00	5.564+01	1.055+02
ELEC (kWh/DAY)						
PROD	2.446+02	1.223+03	3.058+03	6.116+03	1.835+04	3.058+04
USED	2.446+02	1.062+03	1.217+03	1.250+03	1.250+03	1.250+03
VAL($)	1.319+01	5.727+01	6.562+01	6.740+01	6.740+01	6.740+01
XPORT	0.000+00	1.610+02	1.841+03	4.866+03	1.710+04	2.933+04
VAL($)	0.000+00	9.982+00	1.141+02	3.017+02	1.060+03	1.818+03
ΣVAL	17.33	87.95	231.49	441.01	1,207.09	1,965.48
VMSQ	7.80	7.92	8.23	7.94	7.24	7.08

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Break, Cake SIC 2051
CA Spring/Fall

CASE DESCRIF	CASE DESCRIF	CASE DESCRIF	CASE DESCRIF	CASE DESCRIF	CASE DESCRI
2051SF	2051SF	2051SF	2051SF	2051SF	2051SF
DT=1.920E0	DT=1.920E0	DT=1.920E0	DT=1.920E0	DT=1.920E0	DT=1.920E0
DE=1.250E2	DE=1.250E2	DE=1.250E2	DE=1.250E2	DE=1.250E2	DE=1.250E2
S=2.000E2	S=1.000E3	S=2.500E3	S=5.000E3	S=1.500E4	S=2.500E4
Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0
Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2
Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-
ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-
DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E

THRML	MBtu/DAY	THRML	MBtu/DAY	THRML	MBtu/DAY	THRML	MBtu/DAY	THRML	MBtu/DAY	THRML	MBtu/DAY
PROD	1.053+00	PROD	5.265+00	PROD	1.316+01	PROD	2.633+01	PROD	7.898+01	PROD	1.316+02
USED	1.053+00	USED	5.265+00	USED	1.316+01	USED	2.015+01	USED	2.262+01	USED	2.304+01
VAL($)	4.366+00	VAL($)	2.183+01	VAL($)	5.458+01	VAL($)	8.355+01	VAL($)	9.380+01	VAL($)	9.554+01
DUMP	0.000+00	DUMP	0.000+00	DUMP	0.000+00	DUMP	6.176+00	DUMP	5.636+01	DUMP	1.086+02
ELEC	kWh/DAY	ELEC	kWh/DAY	ELEC	kWh/DAY	ELEC	kWh/DAY	ELEC	kWh/DAY	ELEC	kWh/DAY
PROD	2.629+02	PROD	1.314+03	PROD	3.286+03	PROD	6.572+03	PROD	1.972+04	PROD	3.266+04
USED	2.629+02	USED	1.197+03	USED	1.392+03	USED	1.475+03	USED	1.500+03	USED	1.500+03
VAL($)	1.417+01	VAL($)	6.456+01	VAL($)	7.506+01	VAL($)	7.953+01	VAL($)	8.088+01	VAL($)	8.088+01
XPORT	0.000+00	XPORT	1.170+02	XPORT	1.894+03	XPORT	5.097+03	XPORT	1.822+04	XPORT	3.136+04
VAL($)	0.000+00	VAL($)	7.254+00	VAL($)	1.174+02	VAL($)	3.160+02	VAL($)	1.129+03	VAL($)	1.944+03
ΣVAL	18.54	ΣVAL	93.65	ΣVAL	247.07	ΣVAL	479.10	ΣVAL	1,304.07	ΣVAL	2,120.74
VMSO	16.96	VMSO	17.11	VMSO	18.09	VMSO	17.53	VMSO	15.91	VMSO	15.52

Bread, Cake SIC 2051
CA Summer

CASE DESCRIF	CASE DESCRIF	CASE DESCRIF	CASE DESCRIF	CASE DESCRIF	CASE DESCRI
2051SM	2051SM	2051SM	2051SM	2051SM	2051SM
DT=1.920E0	DT=1.920E0	DT=1.920E0	DT=1.920E0	DT=1.920E0	DT=1.920E0
DE=1.250E2	DE=1.250E2	DE=1.250E2	DE=1.250E2	DE=1.250E2	DE=1.250E2
S=2.000E2	S=1.000E3	S=2.500E3	S=5.000E3	S=1.500E4	S=2.500E4
Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0
Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2
Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-
ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-
DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.20

THRML	MBtu/DAY	THRML	MBtu/DAY	THRML	MBtu/DAY	THRML	MBtu/DAY	THRML	MBtu/DAY	THRML	MBtu/DA
PROD	1.334+00	PROD	6.968+00	PROD	1.742+01	PROD	3.484+01	PROD	1.045+02	PROD	1.742+
USED	1.394+00	USED	6.968+00	USED	1.742+01	USED	2.433+01	USED	2.673+01	USED	2.698+
VAL($)	5.779+00	VAL($)	2.889+01	VAL($)	7.224+01	VAL($)	1.009+02	VAL($)	1.108+02	VAL($)	1.115+
DUMP	0.000+00	DUMP	0.000+00	DUMP	0.000+00	DUMP	1.051+01	DUMP	7.779+01	DUMP	1.473+
ELEC	kWh/DAY	**ELEC**	kWh/DAY	**ELEC**	kWh/DAY	**ELEC**	kWh/DAY	**ELEC**	kWh/DAY	**ELEC**	kWh/DAY
PROD	3.454+02	PROD	1.727+03	PROD	4.318+03	PROD	8.636+03	PROD	2.591+04	PROD	4.318+
USED	3.454+02	USED	1.494+03	USED	1.664+03	USED	1.750+03	USED	1.750+03	USED	1.758+
VAL($)	1.863+01	VAL($)	8.055+01	VAL($)	8.972+01	VAL($)	9.436+01	VAL($)	9.436+01	VAL($)	9.436+
XPORT	0.000+00	XPORT	2.334+02	XPORT	2.654+03	XPORT	6.886+03	XPORT	2.416+04	XPORT	4.143+
VAL($)	0.000+00	VAL($)	1.447+01	VAL($)	1.645+02	VAL($)	4.269+02	VAL($)	1.498+03	VAL($)	2.569+
ΣVAL	24.41	ΣVAL	123.91	ΣVAL	326.51	ΣVAL	622.19	ΣVAL	1,703.00	ΣVAL	2,774.48
VMSQ	11.23	"	11.40	VMSQ	12.02	VMSQ	11.45	VMSQ	10.45	VMSQ	10.21

Industrial Organic Chemicals
SIC 2869
CA Winter

CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP
2869W	2869W	2869W	2869W	2869W
DT=6.920E1	DT=6.920E1	DT=6.920E1	DT=6.920E1	DT=6.920E1
DE=1.560E3	DE=1.560E3	DE=1.560E3	DE=1.560E3	DE=1.560E3
S=2.000E2	S=5.000E3	S=1.000E4	S=1.500E4	S=2.500E4
Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0
Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2
Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1
DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1

	Case 1	Case 2	Case 3	Case 4	Case 5
THRML	MBtu/DAY	MBtu/DAY	MBtu/DAY	MBtu/DAY	MBtu/DAY
PROD	9.979-01	2.495+01	4.959+01	7.464+01	1.247+02
USED	9.979-01	2.495+01	4.930+01	7.484+01	1.247+02
VAL($)	4.138+00	1.035+02	2.069+02	3.104+02	5.173+02
DUMP	0.000+00	0.000+00	0.000+00	0.000+00	0.000+00
ELEC	kWh/DAY	kWh/DAY	kWh/DAY	kWh/DAY	kWh/DAY
PROD	2.446+02	6.116+03	1.223+04	1.835+04	3.058+04
USED	2.446+02	6.116+03	1.216+04	1.373+04	1.472+04
VAL($)	1.319+01	3.298+02	6.557+02	7.402+02	7.937+02
XPORT	0.000+00	0.000+00	7.200+01	4.620+03	1.586+04
VAL($)	0.000+00	0.000+00	4.464+00	2.864+02	9.833+02
ΣVAL	17.33	433.23	867.03	1,337.01	2,294.28
VMSQ	7.80	7.80	7.80	8.03	8.26

VMSO 7.80 VMSO 8.02 VMSO 8.26

Industrial Organic Chemicals
SIC 2869
CA Spring/Fall

	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP
	2869SF	2869SF	2869SF	2869SF	2869SF
	DT=6.920E1	DT=6.920E1	DT=6.920E1	DT=6.920E1	DT=6.920E1
	DE=1.560E3	DE=1.560E3	DE=1.560E3	DE=1.560E3	DE=1.560E3
	S=2.000E2	S=5.000E3	S=1.000E4	S=1.500E4	S=2.500E4
	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0	Pt=3.110E0
	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2	Pe=5.392E-2
	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2	Px=6.200E-2
	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1	ADJ=8.000E-1
	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2
THRML	MBtu/DAY	MBtu/DAY	MBtu/DAY	MBtu/DAY	MBtu/DAY
PROD	1.053+00	2.633+01	5.265+01	7.898+01	1.316+02
USED	1.053+00	2.633+01	5.265+01	7.898+01	1.316+02
VAL($)	4.366+00	1.092+02	2.183+02	3.275+02	5.458+02
DUMP	0.000+00	0.000+00	0.000+00	0.000+00	0.000+00
ELEC	kWh/DAY	kWh/DAY	kWh/DAY	kWh/DAY	kWh/DAY
PROD	2.629+02	6.572+03	1.314+04	1.972+04	3.286+04
USED	2.629+02	6.572+03	1.314+04	1.576+04	1.702+04
VAL($)	1.417+01	3.544+02	7.087+02	8.496+02	9.177+02
XPORT	0.000+00	0.000+00	0.000+00	3.960+03	1.584+04
VAL($)	0.000+00	0.000+00	0.000+00	2.455+02	9.521+02
ΣVAL	18.54	463.52	927.05	1,422.57	2,445.61
VMSO	16.96	16.9[illegible]	16.96	17.36	17.90

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Industrial Organic Chemicals
SIC 2869
CA Summer

CASE DESCRIP	2869SM	2869SM	2869SM	2869SM	2869SM
DT=	6.920E1	6.920E1	6.920E1	6.920E1	6.920E1
DE=	1.560E3	1.560E3	1.560E3	1.560E3	1.560E3
S=	2.000E2	5.000E3	1.000E4	1.500E4	2.500E4
Pt=	3.110E0	3.110E0	3.110E0	3.110E0	3.110E0
Pe=	5.392E-2	5.392E-2	5.392E-2	5.392E-2	5.392E-2
Px=	6.200E-2	6.200E-2	6.200E-2	6.200E-2	6.200E-2
ETA=	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ=	8.000E-1	8.000E-1	8.000E-1	8.000E-1	8.000E-1
DAYS=	9.200E1	9.200E1	9.200E1	9.200E1	9.200E1
THRML (MBtu/DAY)					
PROD	1.394+00	3.484+01	6.968+01	1.045+02	1.742+02
USED	1.394+00	3.484+01	6.968+01	1.045+02	1.742+02
VAL($)	5.779+00	1.445+02	2.889+02	4.334+02	7.224+02
DUMP	0.000+00	0.000+00	0.000+00	0.000+00	0.000+00
ELEC (kWh/DAY)					
PROD	3.454+02	8.636+03	1.727+04	2.591+04	4.318+04
USED	3.454+02	8.636+03	1.722+04	1.932+04	2.036+04
VAL($)	1.863+01	4.657+02	9.287+02	1.042+03	1.098+03
XPORT	0.000+00	0.000+00	4.000+01	6.588+03	2.282+04
VAL($)	0.000+00	0.000+00	2.976+00	4.005+02	1.415+03
ΣVAL	24.41	610.13	1,220.64	1,683.61	3,235.03
VMSQ	11.23	11.23	11.23	11.55	11.90

Metal Coating SIC 3479
AZ Winter

CASE DESCRIF	CASE DESCRIF	CASE DESCRIF	CASE DESCRIF	CASE DESCRIF
3479W	3479W	3479W	3479W	3479W
DT=5.670E-1	DT=5.670E-1	DT=5.670E-1	DT=5.670E-1	DT=5.670E-1
DE=1.780E2	DE=1.780E2	DE=1.780E2	DE=1.780E2	DE=1.780E2
S=2.000E2	S=1.000E3	S=2.500E3	S=5.000E3	S=2.500E4
Pt=2.330E0	Pt=2.330E0	Pt=2.330E0	Pt=2.330E0	Pt=2.330E0
Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2
Px=2.978E-2	Px=2.978E-2	Px=2.978E-2	Px=2.978E-2	Px=2.978E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1
DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1

THRML (MBtu/DAY)					
PROD	1.165+00	5.925+00	1.481+01	2.963+01	1.481+02
USED	1.165+00	4.931+00	5.619+00	5.670+00	5.670+00
VAL($)	3.681+00	1.532+01	1.746+01	1.761+01	1.761+01
DUMP	0.000+00	9.946-01	9.194+00	2.396+01	1.425+02

ELEC (kWh/DAY)					
PROD	2.905+02	1.453+03	3.631+03	7.263+03	3.631+04
USED	2.905+02	1.419+03	1.690+03	1.780+03	1.780+03
VAL($)	1.179+01	5.762+01	6.861+01	7.227+01	7.227+01
XPORT	0.000+00	3.340+01	1.941+03	5.483+03	3.453+04
VAL($)	0.000+00	9.947-01	5.781+01	1.633+02	1.028+03

ΣVAL	15.48	73.95	143.58	253.16	1,118.30
VMSQ	6.96	[illegible]	5.18	4.56	4.03

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Metal Coating SIC 3479
AZ Spring/Fall

CASE DESCRIP	3479SF	3479SF	3479SF	3479SF	3479SF
DT	5.670E-1	5.670E-1	5.670E-1	5.670E-1	5.670E-1
DE	1.780E2	1.780E2	1.780E2	1.780E2	1.780E2
S	2.000E2	1.000E3	2.500E3	5.000E3	2.500E4
Pt	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0
Pe	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS	1.830E2	1.830E2	1.830E2	1.830E2	1.830E2
THRML (MBtu/DAY)					
PROD	1.250+00	6.252+00	1.563+01	3.126+01	1.563+02
USED	1.250+00	5.661+00	6.483+00	6.804+00	6.804+00
VAL($)	3.885+00	1.759+01	2.014+01	2.114+01	2.114+01
DUMP	0.000+00	5.917-01	9.148+00	2.446+01	1.495+02
ELEC (kWh/DAY)					
PROD	3.122+02	1.561+03	3.902+03	7.804+03	3.902+04
USED	3.122+02	1.559+03	1.949+03	2.077+03	2.136+03
VAL($)	1.267+01	6.331+01	7.911+01	8.432+01	8.672+01
XPORT	0.000+00	1.550+00	1.954+03	5.728+03	3.689+04
VAL($)	0.000+00	4.616-02	5.818+01	1.706+02	1.098+03
ΣVAL	16.56	80.94	157.43	276.62	1,206.30
VMSQ	15.15	14.81	11.53	10.10	8.83

ORIGINAL PAGE IS OF POOR QUALITY

Metal Coating SIC 3479
AZ Summer

CASE DESCRIP	3479SM	3479SM	3479SM	3479SM	3479SM
DT	5.670E-1	5.670E-1	5.670E-1	5.670E-1	5.670E-1
DE	1.780E2	1.780E2	1.780E2	1.780E2	1.780E2
S	2.000E2	1.000E3	2.500E3	5.000E3	2.500E4
Pt	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0
Pe	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS	9.200E1	9.200E1	9.200E1	9.200E1	9.200E1
THRML (MBtu/DAY)					
PROD	1.655+00	8.275+00	2.069+01	4.137+01	2.069+02
USED	1.655+00	6.952+00	7.704+00	7.938+00	7.938+00
VAL($)	5.141+00	2.160+01	2.393+01	2.466+01	2.466+01
DUMP	0.000+00	1.323+00	1.298+01	3.344+01	1.989+02
ELEC (kWh/DAY)					
PROD	4.102+02	2.051+03	5.128+03	1.026+04	5.128+04
USED	4.102+02	2.013+03	2.331+03	2.466+03	2.492+03
VAL($)	1.665+01	8.174+01	9.463+01	1.001+02	1.012+02
XPORT	0.000+00	3.780+01	2.797+03	7.789+03	4.878+04
VAL($)	0.000+00	1.126+00	8.329+01	2.320+02	1.453+03
ΣVAL	21.80	104.46	201.55	356.74	1,578.63
VMSQ	10.03	9.61	7.47	6.55	5.81

Fluid Milk SIC 2026
AZ Winter

CASE DESCRIP	2026W	2026W	2026W	2026W	2026W
DT	1.560E0	1.560E0	1.560E0	1.560E0	1.560E0
DE	3.050E2	3.050E2	3.050E2	3.050E2	3.050E2
S	2.000E2	2.500E3	5.000E3	1.500E4	2.500E4
Pt	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0
Pe	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS	9.000E1	9.000E1	9.000E1	9.000E1	9.000E1
THRML (MBtu/DAY)					
PROD	1.185+00	1.481+01	2.963+01	8.888+01	1.481+02
USED	1.185+00	1.324+01	1.484+01	1.560+01	1.560+01
VAL($)	3.681+00	4.112+01	4.609+01	4.846+01	4.846+01
DUMP	0.000+00	1.577+00	1.479+01	7.328+01	1.325+02
ELEC (kWh/DAY)					
PROD	2.905+02	3.631+03	7.263+03	2.179+04	3.631+04
USED	2.905+02	2.691+03	2.964+03	3.050+03	3.050+03
VAL($)	1.179+01	1.092+02	1.203+02	1.238+02	1.238+02
XPORT	0.000+00	9.406+02	4.299+03	1.874+04	3.326+04
VAL($)	0.000+00	2.801+01	1.280+02	5.580+02	9.906+02
ΣVAL	15.46	178.38	294.44	730.32	1,162.89
VMSQ	6.96	6.42	5.30	4.38	4.12

VMSQ 4.38 VMSQ 4.19

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Fluid Milk SIC 2026
AZ Spring/Fall

CASE DESCRIP	2026SF	2026SF	2026SF	2026SF	2026SF
DT	1.560E0	1.560E0	1.560E0	1.560E0	1.560E0
DE	3.050E2	3.050E2	3.050E2	3.050E2	3.050E2
S	2.000E2	2.500E3	5.000E3	1.500E4	2.500E4
Pt	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0
Pe	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS	1.830E2	1.830E2	1.830E2	1.830E2	1.830E2
THRML (MBtu/DAY)					
PROD	1.250+00	1.563+01	3.126+01	9.378+01	1.563+02
USED	1.250+00	1.502+01	1.723+01	1.872+01	1.872+01
VAL($)	3.885+00	4.665+01	5.351+01	5.816+01	5.816+01
DUMP	0.000+00	6.139-01	1.404+01	7.506+01	1.376+02
ELEC (kWh/DAY)					
PROD	3.122+02	3.902+03	7.804+03	2.341+04	3.902+04
USED	3.122+02	3.088+03	3.387+03	3.660+03	3.660+03
VAL($)	1.267+01	1.254+02	1.375+02	1.486+02	1.486+02
XPORT	0.000+00	8.138+02	4.417+03	1.975+04	3.536+04
VAL($)	0.000+00	2.423+01	1.315+02	5.882+02	1.053+03
ΣVAL	16.56	196.27	322.57	794.99	1,255.81
VMSQ	15.15	14.37	11.81	9.70	9.22

Fluid Milk SIC 2026
AZ Summer

CASE DESCRIP	Case 1	Case 2	Case 3	Case 4	Case 5
	2026SM	2026SM	2026SM	2026SM	2026SM
DT	1.560E0	1.560E0	1.560E0	1.560E0	1.560E0
DE	3.050E2	3.050E2	3.050E2	3.050E2	3.050E2
S	2.000E2	2.500E3	5.000E3	1.500E4	2.500E4
Pt	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0
Pe	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS	9.200E1	9.200E1	9.200E1	9.200E1	9.200E1
THRML (MBtu/DAY)					
PROD	1.655+02	2.069+01	4.137+01	1.241+02	2.969+02
USED	1.655+02	1.866+01	2.052+01	2.184+01	2.184+01
VAL($)	5.141+00	5.798+01	6.375+01	6.785+01	6.785+01
DUMP	0.000+00	2.024+00	2.085+01	1.023+02	1.550+02
ELEC (kWh/DAY)					
PROD	4.102+02	5.128+03	1.026+04	3.077+04	5.128+04
USED	4.102+02	3.783+03	4.050+03	4.270+03	4.270+03
VAL($)	1.665+01	1.536+02	1.644+02	1.734+02	1.734+02
XPORT	0.000+00	1.345+03	6.206+03	2.650+04	4.701+04
VAL($)	0.000+00	4.006+01	1.848+02	7.890+02	1.400+03
ΣVAL	21.80	251.61	412.97	1,630.26	1,641.06
VMSQ	10.63	9.26	7.60	[illegible]	[illegible]

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VMSQ 7.60 VMSQ 6.3 VMSQ 6.04

Motor Vehicles SIC 3711
AZ Winter

	Case 1	Case 2	Case 3	Case 4
CASE DESCRIP	3711W	3711W	3711W	3711W
DT	6.950E1	6.950E1	6.950E1	6.950E1
DE	5.820E3	5.820E3	5.820E3	5.820E3
S	2.000E2	2.500E4	5.000E4	1.000E5
Pt	2.330E0	2.330E0	2.330E0	2.330E0
Pe	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS	9.000E1	9.000E1	9.000E1	9.000E1
THRML (MBtu/DAY)				
PROD	1.185+00	1.481+02	2.963+02	5.925+02
USED	1.185+00	1.481+02	2.963+02	5.649+02
VAL($)	3.681+00	4.602+02	9.204+02	1.755+03
DUMP	0.000+00	0.000+00	0.000+00	2.759+01
ELEC (kWh/DAY)				
PROD	2.905+02	3.631+04	7.263+04	1.453+05
USED	2.905+02	3.631+04	5.186+04	5.675+04
VAL($)	1.179+01	1.474+03	2.105+03	2.304+03
XPORT	0.000+00	0.000+00	2.077+04	8.851+04
VAL($)	0.000+00	0.000+00	6.186+02	2.636+03
ΣVAL	15.49	1,934.52	3,644.29	6,654.77
VMSQ	6.96	6.96	6.56	6.03

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Motor Vehicles SIC 3711
AZ Spring/Fall

CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP
3711SF	3711SF	3711SF	3711SF
DT=6.950E1	DT=6.950E1	DT=6.950E1	DT=6.950E1
DE=5.820E3	DE=5.820E3	DE=5.820E3	DE=5.820E3
S=2.000E2	S=2.500E4	S=5.000E4	S=1.000E5
Pt=2.330E0	Pt=2.330E0	Pt=2.330E0	Pt=2.330E0
Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2
Px=2.978E-2	Px=2.978E-2	Px=2.978E-2	Px=2.978E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1
DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2

	Case 1	Case 2	Case 3	Case 4
THRML	MBtu/DAY	MBtu/DAY	MBtu/DAY	MBtu/DAY
PROD	1.250+00	1.563+02	3.126+02	6.252+02
USED	1.250+00	1.563+02	3.126+02	6.243+02
VAL($)	3.885+00	4.856+02	9.712+02	1.939+03
DUMP	0.000+00	0.000+00	0.000+00	9.615-01
ELEC	kWh/DAY	kWh/DAY	kWh/DAY	kWh/DAY
PROD	3.122+02	3.902+04	7.804+04	1.561+05
USED	3.122+02	3.902+04	5.953+04	6.495+04
VAL($)	1.267+01	1.584+03	2.417+03	2.637+03
XPORT	0.000+00	0.000+00	1.852+04	9.114+04
VAL($)	0.000+00	0.000+00	5.514+02	2.714+03
ΣVAL	16.56	2,069.85	3,939.37	7,290.29
VMSQ	15.15	15.15	14.42	13.34

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Motor Vehicles SIC 3711
AZ Summer

CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP
3711SM	3711SM	3711SM	3711SM
DT=6.950E1	DT=6.950E1	DT=6.950E1	DT=6.950E1
DE=5.820E3	DE=5.820E3	DE=5.820E3	DE=5.820E3
S=2.000E2	S=2.500E4	S=5.000E4	S=1.000E5
Pt=2.330E0	Pt=2.330E0	Pt=2.330E0	Pt=2.330E0
Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2
Px=2.978E-2	Px=2.978E-2	Px=2.978E-2	Px=2.978E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1
DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1	DAYS=9.200E1

THRML (MBtu/DAY)				
PROD	1.655+00	2.069+02	4.137+02	8.275+02
USED	1.655+00	2.069+02	4.137+02	7.977+02
VAL($)	5.141+00	6.427+02	1.285+03	2.478+03
DUMP	0.000+00	0.000+00	0.000+00	2.975+01

ELEC (kWh/DAY)				
PROD	4.102+02	5.128+04	1.026+05	2.051+05
USED	4.102+02	5.128+04	7.257+04	7.763+04
VAL($)	1.665+01	2.082+03	2.946+03	3.152+03
XPORT	0.000+00	0.000+00	2.998+04	1.275+05
VAL($)	0.000+00	0.000+00	8.929+02	3.796+03

ΣVAL	21.80	2,724.49	5,124.57	9,426.27
VMSO	10.03	10.03	9.43	8.67

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Bread, Cake SIC 2051
AZ Winter

CASE DESCRIP	2051W	2051W	2051W	2051W	2051W	2051W
DT	1.920E0	1.920E0	1.920E0	1.920E0	1.920E0	1.920E0
DE	1.250E2	1.250E2	1.250E2	1.250E2	1.250E2	1.250E2
S	2.000E2	1.000E3	2.500E3	5.000E3	1.500E4	2.500E4
Pt	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0
Pe	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS	9.000E1	9.000E1	9.000E1	9.000E1	9.000E1	9.000E1
THRML (MBtu/DAY)						
PROD	1.125+00	5.925+00	1.481+01	2.963+01	8.888+01	1.481+02
USED	1.185+00	5.925+00	1.473+01	1.772+01	1.928+01	1.928+01
VAL($)	3.661+00	1.841+01	4.575+01	5.504+01	5.965+01	5.965+01
DUMP	0.000+00	0.000+00	8.706-02	1.191+01	6.928+01	1.289+02
ELEC (kWh/DAY)						
PROD	2.305+02	1.453+03	3.631+03	7.263+03	2.179+04	[illegible]
USED	2.905+02	1.037+03	1.234+03	1.250+03	1.250+03	1.250+03
VAL($)	1.179+01	4.455+01	5.011+01	5.075+01	5.075+01	5.075+01
XPORT	0.000+00	3.553+02	2.397+03	6.013+03	2.054+04	3.506+04
VAL($)	0.000+00	1.058+01	7.139+01	1.791+02	6.116+02	1.044+03
ΣVAL	15.48	73.54	167.25	284.65	722.83	1,154.60
VMSQ	6.96	6.62	6.02	5.13	4.33	4.16

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Bread, Cake SIC 2051
AZ Spring/Fall

CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP
2051SF	2051SF	2051SF	2051SF	2051SF	2051SF
DT=1.920E0	DT=1.920E0	DT=1.920E0	DT=1.920E0	DT=1.920E0	DT=1.929E0
DE=1.250E2	DE=1.250E2	DE=1.250E2	DE=1.250E2	DE=1.250E2	DE=1.250E2
S=2.000E2	S=1.000E3	S=2.500E3	S=5.000E3	S=1.500E4	S=2.500E4
Pt=2.330E0	Pt=2.330E0	Pt=2.330E0	Pt=2.330E0	Pt=2.330E0	Pt=2.330E0
Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2
Px=2.978E-2	Px=2.978E-2	Px=2.978E-2	Px=2.978E-2	Px=2.978E-2	Px=2.978E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1
DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2	DAYS=1.830E2

THRML (MBtu/DAY)						
PROD	1.250+00	6.252+00	1.563+01	3.126+01	9.378+01	1.563+02
USED	1.250+00	6.252+00	1.563+01	2.069+01	2.230+01	2.384+01
VAL($)	3.895+00	1.942+01	4.856+01	6.427+01	7.115+01	7.158+01
DUMP	0.000+00	0.000+00	0.000+00	1.057+01	7.088+01	1.333+02

ELEC (kWh/DAY)						
PROD	3.122+02	1.561+03	3.902+03	7.804+03	2.341+04	3.902+04
USED	3.122+02	1.258+03	1.419+03	1.494+03	1.500+03	1.500+03
VAL($)	1.267+01	5.107+01	5.760+01	6.065+01	6.030+01	6.090+01
XPORT	0.000+00	3.030+02	2.484+03	6.311+03	2.191+04	3.752+04
VAL($)	0.000+00	9.023+00	7.396+01	1.879+02	6.526+02	1.117+03

ΣVAL	16.56	79.52	[illegible]	312.84	784.61	1,249.86
VMSO	15.15	14.55	13.18	11.45	9.57	9.15

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Bread, Cake SIC 2051
AZ Summer

CASE DESCRIP	2051SM	2051SM	2051SM	2051SM	2051SM	2051SM
DT=	1.920E0	1.920E0	1.920E0	1.920E0	1.920E0	1.920E0
DE=	1.250E2	1.250E2	1.250E2	1.250E2	1.250E2	1.250E2
S=	2.000E2	1.000E3	2.500E3	5.000E3	1.500E4	2.500E4
Pt=	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0
Pe=	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px=	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA=	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ=	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS=	9.200E1	9.200E1	9.200E1	9.200E1	9.200E1	9.200E1
THRML (MBtu/DAY)						
PROD	1.655+00	8.275+00	2.069+01	4.137+01	1.241+02	2.069+02
USED	1.655+00	8.275+00	2.064+01	2.484+01	2.688+01	2.688+01
VAL($)	5.141+00	2.571+01	6.412+01	7.717+01	8.351+01	8.351+01
DUMP	0.000+00	0.000+00	4.835-02	1.653+01	9.724+01	1.800+02
ELEC (kWh/DAY)						
PROD	4.102+02	2.051+03	5.128+03	1.026+04	3.077+04	5.128+04
USED	4.102+02	1.546+03	1.695+03	1.758+03	1.758+03	1.758+03
VAL($)	1.665+01	6.277+01	6.881+01	7.105+01	7.105+01	7.105+01
XPORT	0.000+00	5.051+02	3.433+03	8.505+03	2.902+04	4.953+04
VAL($)	0.000+00	1.504+01	1.022+02	2.533+02	8.641+02	1.475+03
ΣVAL	21.50	103.51	235.16	401.51	1,318.65	1,629.45
VMSQ	10.03	9.52	8.65	7.39	6.25	6.00

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Industrial Organic Chemicals
SIC 2869
AZ Winter

CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP	CASE DESCRIP
2869W	2869W	2869W	2869W	2869W
DT=6.920E1	DT=6.920E1	DT=6.920E1	DT=6.920E1	DT=6.920E1
DE=1.560E3	DE=1.560E3	DE=1.560E3	DE=1.560E3	DE=1.560E3
S=2.000E2	S=5.000E3	S=1.000E4	S=1.500E4	S=2.500E4
Pt=2.330E0	Pt=2.330E0	Pt=2.330E0	Pt=2.330E0	Pt=2.330E0
Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2	Pe=4.060E-2
Px=2.978E-2	Px=2.978E-2	Px=2.978E-2	Px=2.978E-2	Px=2.978E-2
ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1	ETA=7.500E-1
ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1	ADJ=9.500E-1
DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1	DAYS=9.000E1

	Case 1	Case 2	Case 3	Case 4	Case 5
THRML (MBtu/DAY)					
PROD	1.185+00	2.963+01	5.925+01	8.888+01	1.481+02
USED	1.185+00	2.963+01	5.925+01	8.888+01	1.461+02
VAL($)	3.691+00	9.204+01	1.541+02	2.761+02	4.602+02
DUMP	0.000+00	0.000+00	0.000+00	0.000+00	0.000+00
ELEC (kWh/DAY)					
PROD	2.905+02	7.263+03	1.453+04	2.179+04	3.631+04
USED	2.905+02	7.263+03	1.307+04	1.408+04	1.513+04
VAL($)	1.179+01	2.949+02	5.308+02	5.715+02	6.144+02
XPORT	0.000+00	0.000+00	1.451+03	7.712+03	2.118+04
VAL($)	0.000+00	0.000+00	4.321+01	2.297+02	6.389+02
ΣVAL	15.46	386.98	758.11	1,077.27	1,785.34
VMSQ	6.96	6.96	6.82	6.46	6.14

Industrial Organic Chemicals
SIC 2869
AZ Spring/Fall

CASE DESCRIP	2869SF	2869SF	2869SF	2869SF	2869SF
DT=	6.920E1	6.920E1	6.920E1	6.920E1	6.920E1
DE=	1.560E3	1.560E3	1.560E3	1.560E3	1.560E3
S=	2.000E2	5.000E3	1.000E4	1.500E4	2.500E4
Pt=	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0
Pe=	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px=	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA=	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ=	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS=	1.830E2	1.830E2	1.830E2	1.830E2	1.830E2
THRML (MBtu/DAY)					
PROD	1.250+00	3.126+01	6.252+01	9.378+01	1.563+02
USED	1.250+00	3.126+01	6.252+01	9.378+01	1.563+02
VAL($)	3.685+00	9.712+01	1.942+02	2.914+02	4.856+02
DUMP	0.000+00	0.000+00	0.000+00	0.000+00	0.000+00
ELEC (kWh/DAY)					
PROD	3.122+02	7.804+03	1.561+04	2.341+04	3.902+04
USED	3.122+02	7.804+03	1.471+04	1.619+04	1.729+04
VAL($)	1.267+01	3.169+02	5.971+02	6.574+02	7.018+02
XPORT	0.000+00	0.000+00	9.020+02	7.221+03	2.174+04
VAL($)	0.000+00	0.000+00	2.686+01	2.150+02	6.473+02
ΣVAL	16.55	413.97	916.18	1,163.78	1,834.68
VMSQ	15.15	15.15	14.97	14.[illegible]	13.43

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Industrial Organic Chemicals
SIC 2869
AZ Summer

CASE DESCRIP	2869SM	2869SM	2869SM	2869SM	2869SM
DT	6.920E1	6.920E1	6.920E1	6.920E1	6.920E1
DE	1.560E3	1.560E3	1.560E3	1.560E3	1.560E3
S	2.000E2	5.000E3	1.000E4	1.500E4	2.500E4
Pt	2.330E0	2.330E0	2.330E0	2.330E0	2.330E0
Pe	4.060E-2	4.060E-2	4.060E-2	4.060E-2	4.060E-2
Px	2.978E-2	2.978E-2	2.978E-2	2.978E-2	2.978E-2
ETA	7.500E-1	7.500E-1	7.500E-1	7.500E-1	7.500E-1
ADJ	9.500E-1	9.500E-1	9.500E-1	9.500E-1	9.500E-1
DAYS	9.200E1	9.200E1	9.200E1	9.200E1	9.200E1
THRML (MBtu/DAY)					
PROD	1.655+00	4.137+01	8.275+01	1.241+02	2.069+02
USED	1.655+00	4.137+01	8.275+01	1.241+02	2.069+02
VAL($)	5.141+00	1.285+02	2.571+02	3.856+02	6.427+02
DUMP	0.000+00	0.000+00	0.000+00	0.000+00	0.000+00
ELEC (kWh/DAY)					
PROD	4.102+02	1.026+04	2.051+04	3.077+04	5.128+04
USED	4.102+02	1.026+04	1.842+04	1.973+04	2.067+04
VAL($)	1.665+01	4.164+02	7.478+02	8.008+02	8.391+02
XPORT	0.000+00	0.000+00	2.091+03	1.104+04	3.061+04
VAL($)	0.000+00	0.000+00	6.227+01	3.288+02	9.115+02
ΣVAL	[illegible]	544.90	1,667.17	1,515.23	2,353.30
VMSQ	10.03	10.03	9.82	9.29	8.81

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APPENDIX D

PROGRAM FOR THE HP-41C CALCULATOR USED IN THIS STUDY

The following program listings are presented, without elaboration, for their possible value to researchers wishing to reproduce or extend the results of this study. They are not included in the contract deliverables.

```
01♦LBL "ASYL"
02 AON
03 "NAMERUN?"
04 PROMPT
05 ASTO 00
06 AOFF
07 ADV
08 SCI 3
09 SF 12
10 "CASE D"
11 ACA
12 "ESCRIP"
13 ACA
14 PRBUF
15 CLA
16 ARCL 00
17 ACA
18 PRBUF
19 "DT="
20 ARCL 40
21 ACA
22 PRBUF
23 "DE="
24 ARCL 41
25 ACA
26 PRBUF
27 "S="
28 ARCL 42
29 ACA
30 PRBUF
31 "P"
32 ACA
33 116
34 ACCHR
35 "="
36 ARCL 43
37 ACA
38 PRBUF
39 "P"
40 ACA
41 101
42 ACCHR
43 "="
44 ARCL 44
45 ACA
46 PRBUF
47 "P"
48 ACA
49 120
50 ACCHR
51 "="
52 ARCL 45
53 ACA
54 PRBUF
55 "ETA="
56 ARCL 46
57 ACA
58 PRBUF
59 "ADJ="
60 ARCL 47
61 ACA
62 PRBUF
63 "DAYS="
64 ARCL 04
65 ACA
66 PRBUF
67 CF 12
68 60.069
69 STO 50
70♦LBL 01
71 0
72 STO IND 50
73 ISG 50
74 GTO 01
75 05.019
76 STO 50
77♦LBL 02
78 RCL IND 50
79 RCL 47
80 *
81 RCL 42
82 *
83 ST+ 60
84 RCL 40
85 -
86 STO 66
87 0
88 X<>Y
89 X<=Y?
90 GTO 03
91 RCL 66
92 ST+ 61
93♦LBL 03
94 RCL 50
95 20
96 +
97 RCL IND X
98 RCL 47
99 *
100 RCL 42
101 *
102 ST+ 63
103 RCL 41
104 -
105 STO 66
106 0
107 X<>Y
108 X<=Y?
109 GTO 04
110 RCL 66
111 ST+ 64
112♦LBL 04
113 ISG 50
114 GTO 02
115 RCL 60
116 RCL 61
117 -
118 STO 62
119 RCL 43
120 *
121 RCL 46
122 /
123 STO 01
124 RCL 63
125 RCL 64
126 -
127 STO 65
128 RCL 44
129 *
130 STO 02
131 RCL 64
132 RCL 45
133 *
134 STO 03
135 ADV
136 ADV
137 SF 12
138 "THRML"
139 ACA
140 PRBUF
141 CF 12
142 14
143 SKPCHR
144 "MB"
145 ACA
146 116
147 ACCHR
148 117
149 ACCHR
150 "/DAY"
151 ACA
152 PRBUF
153 2
154 SKPCHR
155 "PROD"
156 ACA
157 8
158 SKPCHR
159 RCL 60
160 ACX
161 PRBUF
162 ADV
163 2
164 SKPCHR
165 "USED"
166 ACA
167 8
168 SKPCHR
169 RCL 62
170 ACX
171 PRBUF
172 2
173 SKPCHR
174 "VAL($)"
175 ACA
176 6
177 SKPCHR
178 RCL 01
179 ACX
180 PRBUF
181 ADV
182 2
183 SKPCHR
184 "DUMP"
185 ACA
186 8
187 SKPCHR
188 RCL 61
189 ACX
190 PRBUF
191 ADV
192 SF 12
193 "ELEC"
194 ACA
195 PRBUF
196 CF 12
197 14
198 SKPCHR
199 107
200 ACCHR
201 87
202 ACCHR
203 104
204 ACCHR
205 "/DAY"
206 ACA
207 PRBUF
208 ADV
209 2
210 SKPCHR
211 "PROD"
212 ACA
213 8
214 SKPCHR
215 RCL 63
216 ACX
217 PRBUF
218 ADV
219 2
220 SKPCHR
221 "USED"
222 ACA
223 8
224 SKPCHR
225 RCL 65
226 ACX
227 PRBUF
228 2
229 SKPCHR
230 "VAL($)"
```

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```
231 [illegible]
232 [illegible]
233 SKPCHR
234 RCL 02
235 ACX
236 PRBUF
237 ADV
238 2
239 SKPCHR
240 "XPORT"
241 ACA
242 7
243 SKPCHR
244 RCL 64
245 ACX
246 PRBUF
247 2
248 SKPCHR
249 "VAL($)"
250 ACA
251 6
252 SKPCHR
253 RCL 03
254 ACX
255 PRBUF
256 ADV
257 FIX 2
258 126
259 ACCHR
260 "VAL"
261 ACA
262 1
263 SKPCHR
264 RCL 01
265 RCL 02
266 +
267 RCL 03
268 +
269 STO 00
270 ACX
271 PRBUF
272 ADV
273 SF 12
274 "VMSQ"
275 ACA
276 1
277 SKPCHR
278 RCL 04
279 RCL 00
280 *
281 RCL 42
282 /
283 ACX
284 PRBUF
285 CF 12
286 END
```

```
[illegible]
02 ADV
03 XEQ "PR1"
04 X=Y?
05 XEQ 01
06 GTO 02
07♦LBL 01
08 RCL 50
09 RCL 57
10 -
11 STO 52
12 CLA
13 ARCL 51
14 RCL 52
15 FIX 0
16 ARCL X
17 SCI 3
18 ARCL 59
19 PROMPT
20 STO IND 50
21 ISG 50
22 GTO 01
23♦LBL 02
24 "LIST"
25 ARCL 51
26 ARCL 59
27 ASTO 56
28 XEQ "PR1"
29 X=Y?
30 XEQ 03
31 GTO 40
32♦LBL 03
33 RCL 49
34 RCL 57
35 -
36 STO 52
37 CLA
38 ARCL 51
39 RCL 52
40 FIX 0
41 ARCL X
42 SCI 3
43 ARCL 58
44 ARCL IND 49
45 ACA
46 PRBUF
47 ISG 49
48 GTO 03
49♦LBL 40
50 RTN
51 END
```

```
[illegible]
[illegible]
03 "TFL?"
04 PROMPT
05 PRX
06 STO 01
07 "DPE?"
08 PROMPT
09 PRX
10 STO 02
11 "XPE?"
12 PROMPT
13 PRX
14 STO 03
15 RCL 01
16 RCL 04
17 *
18 STO 10
19 RCL 02
20 RCL 03
21 +
22 RCL 05
23 *
24 ST+ 10
25 RCL 01
26 RCL 06
27 *
28 STO 11
29 RCL 02
30 RCL 03
31 +
32 RCL 07
33 *
34 ST+ 11
35 RCL 01
36 RCL 08
37 *
38 STO 12
39 RCL 02
40 RCL 03
41 +
42 RCL 09
43 *
44 ST+ 12
45 "PV<15>="
46 ARCL 10
47 ACA
48 PRBUF
49 "PV<20>="
50 ARCL 11
51 ACA
52 PRBUF
53 "PV<25>="
54 ARCL 12
55 ACA
56 PRBUF
57 ADV
58 GTO 01
59 END
```

```
01♦LBL "$ALW"
02♦LBL 01
03 "MSA?"
04 PROMPT
05 STO 00
06 "PVFL<15>?"
07 PROMPT
08 STO 07
09 "PVFL<20>?"
10 PROMPT
11 STO 08
12 "PVFL<25>?"
13 PROMPT
14 STO 09
15 "$ALW<15>="
16 RCL 07
17 RCL 01
18 RCL 00
19 *
20 /
21 ARCL X
22 ACA
23 PRBUF
24 "$ALW<20>="
25 RCL 08
26 RCL 02
27 RCL 00
28 *
29 /
30 ARCL X
31 ACA
32 PRBUF
33 "$ALW<25>="
34 RCL 09
35 RCL 03
36 RCL 00
37 *
38 /
39 ARCL X
40 ACA
41 PRBUF
42 GTO 01
43 END
```

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```
01♦LBL "LDASVL"
02 ADV
03 AON
04 "="
05 ASTO 58
06 "?"
07 ASTO 59
08 SF 12
09 "NAMERUN=?"
10 PROMPT
11 ACA
12 PRBUF
13 CF 12
14 AOFF
15 "NDAYS?"
16 PROMPT
17 STO 04
18 05.019
19 STO 49
20 STO 50
21 "T"
22 ASTO 51
23 0
24 STO 57
25 "CH TI?"
26 ASTO 56
27 XEQ "ASVBSE"
28 25.039
29 STO 49
30 STO 50
31 "E"
32 ASTO 51
33 20
34 STO 57
35 "CH EI?"
36 ASTO 56
37 XEQ "ASVBSE"
38 END
```

APPENDIX E

INDUSTRY DATA FOR SYNTHETIC PDS DEMAND CURVES

Table E.1 presents a listing of important industries in Standard Industrial Classification (SIC) codes 20 through 39. At the four-digit level, the number of industries represented is quite large. For purposes of this study, SAI has screened this list twice. The first screening is based on a relevant set of Criteria for Elimination, arranged across the top of Table #.1. Their explanations are contained in notes to the table.

After applying the screens of Table E.1, there are still 75 four-digit industries which remain eligible for evaluation. These industries, with 1976 nationwide industry-level data on total purchased fuel and electricity, are listed in Table E.2. The screening criteria of Table E.1 are used only as a priori grounds for disqualifying an industry from further consideration. Another important discussion of industry suitability is the extent to which activity in that industry is represented in the two utility service territories chosen as the geographical framework for the study. Because Arizona has less complete economic infrastructure than Southern California, the industries selected for evaluation are based on their relative presence in Arizona.

TABLE E.1 SELECTION OF INDUSTRIES COMPATIBLE WITH DISH COGENERATION SYSTEMS

SIC	Industry	CRITERIA FOR ELIMINATION: No steam or HW[a]	Temperature 700°F[b]	$T/E \leq 1$[c]	Declining Production[d]	Fuel Supply[e]	$E/V \leq 1\%$[f]	Other Studies[g]	No Information[h]
2011	Meat packing plants				●				
2013	Sausage & other prepared meats								
2016	Poultry dressing plants								
2017	Poultry & egg processing								●
2021	Creamery butter				●				
2022	Cheese, natural & processed								
2023	Condensed & evaporated milk							●	
2024	Ice cream & frozen desserts			●			●		
2026	Fluid milk								
2032	Canned specialties							●	
2033	Canned fruits & vegetables								
2034	Dehydrated fruits, vegetables, soups	●							
2035	Pickles, sauces, salad dressings								
2037	Frozen fruits & vegetables								
2038	Frozen specialties							●	
2041	Flour & other grain mill products			●					
2043	Cereal breakfast foods							●	
2044	Rice milling								
2045	Blended & prepared flour						●		●
2046	Wet corn milling								
2047	Dog, cat, & other pet food							●	
2048	Prepared feeds, nec.								
2051	Bread, cake & related products								
2052	Cookies & crackers				●				
2061	Raw cane sugar								●
2062	Cane sugar refining							●	
2063	Beet sugar				●				
2065	Confectionery products								
2066	Chocolate & cocoa products								
2067	Chewing gum			●					

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature 700°F[b]	T/E ≤ 1[c]	Declining Production[d]	Fuel Supply[e]	E/V ≤ 1%[f]	Other Studies[g]	No Information[h]
		CRITERIA FOR ELIMINATION							
2074	Cottonseed oil mills								●
2075	Soybean oil mills							●	
2076	Vegetable oil mills, nec.								
2077	Animal & marine fats & oils								
2079	Shortening & cooking oils								
2082	Malt beverages								
2083	Malt								●
2084	Wines, brandy, & brandy spirits						●		●
2085	Distilled liquor, exc. brandy				●				
2086	Bottled & canned soft drinks								
2087	Flavoring extracts & sirups, nec.						●		
2091	Canned & cured seafoods								
2092	Fresh or frozen pkgd. fish								
2095	Roasted coffee								
2097	Manufactured ice			●					
2098	Macaroni & spaghetti			●					
2099	Food preparations, nec.								●
2111	Cigarettes						●		
2121	Cigars						●		
2131	Chewing & smoking tobacco						●		
2141	Tobacco stemming & redrying						●		
2211	Weaving mills, cotton			●					
2221	Weaving mills, synthetics			●					
2231	Weaving & finishing mills, wool								●
2241	Narrow fabric mills			●					
2251	Women's hosiery, exc. socks							●	
2252	Hosiery, nec.							●	
2253	Knit outerwear mills								
2254	Knit underwear mills								
2257	Circular knit fabric mills								

TABLE E.1 (cont)

SIC	Industry	CRITERIA FOR ELIMINATION							
		No steam or HW[a]	Temperature 700°F[b]	T/E < 1[c]	Declining Production[d]	Fuel Supply[e]	E/V ≤ 1%[f]	Other Studies[g]	No Information[h]
2258	Warp knit fabric mills								•
2259	Knitting mills, nec.								
2261	Finishing plants, cotton								
2262	Finishing plants, synthetic								•
2269	Finishing plants, nec.							•	
2271	Woven carpets & rugs								
2272	Tufted carpets & rugs								•
2279	Carpets & rugs, nec.								•
2281	Yarn mills, exc. wool								•
2282	Throwing & winding mills								
2283	Wool yarn mills								•
2284	Thread mills								•
2291	Felt goods, exc. woven felts & hats								•
2292	Lace goods								•
2293	Padding & upholstery filling								•
2294	Processed textile waste								•
2295	Coated fabric, not rubberized								•
2296	Tire cord & fabric			•					
2297	Nonwoven fabrics								
2298	Cordage & twine			•					•
2299	Textile goods, nec.								•
2311	Men's & boys' suits & coats			•			•		
2321	Men's & boys' shirts & nightwear			•			•		
2322	Men's & boys' underwear			•			•		
2323	Men's & boys' neckwear			•			•		
2327	Men's & boys' separate trousers			•			•		
2328	Men's & boys' work clothing			•			•		
2329	Men's & boys' clothing, nec.			•			•		
2331	Women's & misses' blouses & waists			•			•		
2335	Women's & misses' dresses			•			•		
2337	Women's & misses' suits & coats			•			•		

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature 700°F[b]	T/E < 1[c]	Declining Production[d]	Fuel Supply[e]	E/V $\leq$ 1%[f]	Other Studies[g]	No Information[h]
		CRITERIA FOR ELIMINATION							
2339	Women's & misses' outerwear, nec.			●			●		
2341	Women's & misses' underwear			●			●		
2342	Brassieres & allied garments			●			●		
2351	Millinery			●			●		
2352	Hats & caps, exc. millinery			●			●		
2361	Children's dresses & blouses			●			●		
2363	Children's coats & suits			●			●		
2369	Children's outerwear, nec.			●			●		
2371	Fur goods			●			●		
2381	Fabric dress & work gloves						●		
2384	Robes & dressing gowns			●			●		
2385	Waterproof outer garments			●			●		
2386	Leather & sheeplined clothing			●	●		●		
2387	Apparel belts			●			●		
2389	Apparel & accessories, nec.			●			●		
2391	Curtains & draperies			●			●		
2392	Housefurnishings, nec.			●			●		
2393	Textile bags						●		
2394	Canvas & related products						●		
2395	Pleating & stitching						●		
2396	Automotive & apparel trimmings						●		
2397	Schiffli machine embroideries						●		
2399	Fabricated textile products, nec.						●		
2411	Logging camps & logging contractors					●			
2421	Sawmills & planing mills, general			●		●			
2426	Hardwood dimension & flooring			●		●			
2429	Special products sawmills, nec.					●	●		
2431	Millwork						●		
2434	Wood kitchen cabinets								

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature 700°F[b]	T/E < 1[c]	Declining Production[d]	Fuel Supply[e]	E/V ≤ 1%[f]	Other Studies[g]	No Information[h]
		CRITERIA FOR ELIMINATION							
2435	Hardwood veneer & plywood			●	●				
2436	Softwood veneer & plywood								
2439	Structural wood members, nec.			●					●
2441	Nailed wooden boxes & shook			●					●
2448	Wood pallets & skids			●					●
2449	Wood containers, nec.			●					●
2451	Mobile homes			●					●
2452	Prefabricated wood buildings								●
2491	Wood preserving								
2492	Particleboard					●			
2499	Wood products, nec.								●
2511	Wood household furniture			●			●		
2512	Upholstered household furniture						●		●
2514	Metal household furniture						●		
2515	Mattresses & bedsprings						●		●
2517	Wood TV & radio cabinets						●		●
2519	Household furniture, nec.						●		●
2521	Wood office furniture						●		
2522	Metal office furniture						●		
2531	Public building & related furniture								●
2541	Wood partitions & fixtures						●		●
2542	Metal partitions & fixtures								●
2591	Drapery hardware & blinds & shades								●
2599	Furniture & fixtures, nec.						●		●
2611	Pulpmills					●			
2621	Papermills, exc. building paper					●		●	
2631	Paperboard mills					●			
2641	Paper coating & glazing							●	
2642	Envelopes			●			●		
2643	Bags, exc. textile bags			●	●				

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature 700°F[b]	T/E ≤ 1[c]	Declining Production[d]	Fuel Supply[e]	E/V ≤ 1%[f]	Other Studies[g]	No Information[h]
		CRITERIA FOR ELIMINATION							
2645	Die cut paper & board				●				
2646	Pressed & molded pulp goods								
2647	Sanitary paper products								
2648	Stationery products			●					
2649	Converted paper products, nec.						●		●
2651	Folding paperboard boxes						●		
2652	Set-up paperboard boxes				●		●		
2653	Corrugated & solid fiber boxes			●					
2654	Sanitary food containers			●					
2655	Fiber cans, drums, & similar products				●				
2661	Building paper & building board mills				●				
2711	Newspapers			●			●		
2721	Periodicals			●			●		
2731	Book publishing			●			●		
2732	Book printing			●			●		
2741	Miscellaneous publishing			●			●		
2751	Commercial printing, letterpress			●			●		
2752	Commercial printing, lithographic			●			●		
2753	Engraving & plate printing						●		
2754	Commercial printing, gravure						●		
2761	Manifold business forms						●		
2771	Greeting card publishing						●		
2782	Blankbooks & looseleaf binders						●		
2789	Bookbinding & related work						●		
2791	Typesetting						●		
2793	Photoengraving						●		
2794	Electrotyping & stereotyping						●		
2795	Lithographic platemaking services						●		
2812	Alkalies & chlorine			●				●	
2813	Industrial gases			●					
2816	Inorganic pigments			●					
2819	Industrial inorganic chemicals, nec.		●	●					

TABLE E.1 (cont)

SIC	Industry	CRITERIA FOR ELIMINATION							
		No steam or HW[a]	Temperature 700°F[b]	T/E ≤ 1[c]	Declining Production[d]	Fuel Supply[e]	E/V < 1%[f]	Other Studies[g]	No Information[h]
2821	Plastics materials & resins								
2822	Synthetic rubber								
2823	Cellulosic man-made fibers								
2824	Organic fibers, noncellulosic								
2831	Biological products			●			●		
2833	Medicinals & botanicals								
2834	Pharmaceutical preparations			●			●		
2841	Soap & other detergents								
2842	Polishes & sanitation goods						●		
2843	Surface active agents								
2844	Toilet preparations						●		
2851	Paints & allied products		●	●			●	●	
2861	Gum & wood chemicals								
2865	Cyclic crudes & intermediates								
2869	Industrial organic chemicals, nec.								
2873	Nitrogenous fertilizers								
2874	Phosphatic fertilizers								
2875	Fertilizers, mixing only			●					
2879	Agricultural chemicals, nec.								
2891	Adhesives & sealants								
2892	Explosives								
2893	Printing ink								●
2895	Carbon black								●
2899	Chemical preparations, nec.								●
2911	Petroleum refining								
2951	Paving mixtures & blocks								
2952	Asphalt felts & coatings								
2992	Lubricating oils & greases								
2999	Petroleum & coal products, nec.								●
3011	Tires & inner tubes		●						
3021	Rubber & plastic footwear						●		
3031	Reclaimed rubber								●

TABLE E.1 (cont)

CRITERIA FOR ELIMINATION

SIC	Industry	No steam or HW[a]	Temperature 700^oF[b]	T/E ≤ 1[c]	Declining Production[d]	Fuel Supply[e]	E/V < 1%[f]	Other Studies[g]	No Information[h]
3041	Rubber & plastics hose & belting							●	
3069	Fabricated rubber products, nec.								●
3079	Miscellaneous plastics products			●	●			●	
3111	Leather tanning & finishing				●				
3131	Boot & shoe cut stock & findings						●		●
3142	House slippers				●		●		
3143	Men's footwear exc. athletic				●				
3144	Women's footwear exc. athletic				●				
3149	Footwear, exc. rubber, nec.				●				
3151	Leather gloves & mittens				●				
3161	Luggage						●		
3171	Women's handbags & purses				●		●		
3172	Personal leather goods, nec.								●
3199	Leather goods, nec.						●		●
3211	Flat glass	●	●						
3221	Glass containers	●	●						
3229	Pressed & blown glass, nec.	●	●						
3231	Products of purchased glass								●
3241	Cement, hydraulic	●	●						
3251	Brick & structural clay tile	●	●						
3253	Ceramic wall & floor tile	●	●						
3255	Clay refractories	●	●						
3259	Structural clay products, nec.	●							
3261	Vitreous plumbing fixtures		●						
3262	Vitreous china food utensils				●				
3263	Fine earthenware food utensils				●				
3264	Porcelain electrical supplies		●						
3269	Pottery products, nec.								
3271	Concrete block & brick								
3272	Concrete products, nec.								
3273	Ready-mixed concrete						●	●	
3274	Lime	●	●						

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature 700°F[b]	T/E < 1[c]	Declining Production[d]	Fuel Supply[e]	E/V < 1%[f]	Other Studies[g]	No Information[h]
		CRITERIA FOR ELIMINATION							
3275	Gypsum products		●						
3281	Cut stone & stone products			●					
3291	Abrasive products								●
3292	Asbestos products								●
3293	Gaskets, packing, & sealing devices								●
3295	Minerals, ground or treated	●	●						
3296	Mineral wool	●							
3297	Nonclay refractories		●						
3299	Nonmetallic minerals products, nec.								●
3312	Blast furnaces & steel mills	●	●			●			
3313	Electrometallurgical products			●				●	
3315	Steel wire & related products	●	●						
3316	Cold finishing of steel shapes							●	
3317	Steel pipe & tubes								
3321	Gray iron foundries							●	
3322	Malleable iron foundries		●						
3324	Steel investment foundries		●						
3325	Steel foundries, nec.		●						
3331	Primary copper			●					
3332	Primary lead			●	●				
3333	Primary zinc			●					
3334	Primary aluminum			●					
3339	Primary nonferrous metals, nec.			●					
3341	Secondary nonferrous metals		●						●
3351	Copper rolling & drawing							●	
3353	Aluminum sheet, plate, & foil							●	
3354	Aluminum extruded products							●	
3355	Aluminum rolling & drawing, nec.							●	
3356	Nonferrous rolling & drawing, nec.							●	
3357	Nonferrous wiredrawing & insulating							●	
3361	Aluminum foundries (castings)		●						
3362	Brass, bronze, & copper foundries		●						

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature $700^{0}F$[b]	T/E < 1[c]	Declining Production[d]	Fuel Supply[e]	E/V < 1%[f]	Other Studies[g]	No Information[h]
		CRITERIA FOR ELIMINATION							
3369	Nonferrous foundries, nec.								●
3398	Metal heat treating		●						
3399	Primary metal products, nec.								●
3411	Metal cans								
3412	Metal barrels, drums, & pails								●
3421	Cutlery						●		
3423	Hand & edge tools, nec.								●
3425	Handsaws & saw blades			●			●		●
3429	Hardware, nec.						●		●
3431	Metal sanitary ware								
3432	Plumbing fittings & brass goods						●		
3433	Heating equipment exc. electric								●
3441	Fabricated structural metal		●	●			●		
3442	Metal doors, sash & trim			●					
3443	Fabricated platework (boiler shops)				●				
3444	Sheet metalwork								
3446	Architectural metalwork								●
3448	Prefabricated metal buildings			●					
3449	Miscellaneous metalwork								●
3451	Screw machine products			●			●		
3452	Bolts, nuts, rivets & washers				●				
3462	Iron & steel forgings		●					●	
3463	Nonferrous forgings		●					●	
3465	Automotive stampings			●					
3466	Crowns & closures								●
3469	Metal stampings, nec.								●
3471	Plating & polishing								
3479	Metal coating & allied services, nec.			●					
3482	Small arms ammunition								●
3483	Ammunition, exc. for small arms, nec.								●
3484	Small arms								●
3489	Ordnance & accessories, nec.								●

TABLE E.1 (cont)

SIC	Industry	CRITERIA FOR ELIMINATION							
		No steam or HW[a]	Temperature $700^{o}F$[b]	T/E < 1[c]	Declining Production[d]	Fuel Supply[e]	E/V ≤ 1%[f]	Other Studies[g]	No Information[h]
3493	Steel springs exc. wire								
3494	Valves & pipe fittings		●						●
3495	Wire springs								
3496	Misc. fabricated wire products			●					
3497	Metal foil & leaf			●					
3498	Fabricated pipe and fittings			●					
3499	Fabricated metal products, nec.								●
3511	Turbines & turbine generator sets				●		●		
3519	Internal combustion engines, nec.						●		
3523	Farm machinery & equipment						●		
3524	Lawn & garden equipment						●		
3531	Construction machinery						●		
3532	Mining machinery						●		
3533	Oilfield machinery			●			●		
3534	Elevators & moving stairways						●		
3535	Conveyors & conveying equipment			●			●		
3536	Hoists, cranes & monorails						●		
3537	Industrial trucks & tractors						●		
3541	Machine tools, metal-cutting types						●		
3542	Machine tools, metal-forming types		●	●			●		
3544	Special dies, tools, jigs, & fixtures						●		
3545	Machine tool accessories			●			●		
3546	Power driven hand tools			●			●		
3547	Rolling mill machinery						●		
3549	Metalworking machinery, nec.						●		
3551	Food products machinery						●		
3552	Textile machinery						●		
3553	Woodworking machinery			●			●		
3554	Paper industries machinery						●		
3555	Printing trades machinery						●		

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature 700°F[b]	T/E ≤ 1[c]	Declining Production[d]	Fuel Supply[e]	E/V ≤ 1%[f]	Other Studies[g]	No Information[h]
		CRITERIA FOR ELIMINATION							
3559	Special industry machinery, nec.						●		
3561	Pumps & pumping equipment			●			●		
3562	Ball & roller bearings						●		
3563	Air & gas compressors						●		
3564	Blowers & fans				●		●		
3565	Industrial patterns						●		
3566	Speed changers, high speed drives, & gears						●		
3567	Industrial furnaces & ovens						●		
3568	Power transmission equipment, nec. .						●		
3569	General industry machinery, nec. ...						●		
3573	Electronic computing equipment			●			●		
3574	Calculating & accounting machines ..			●			●		
3576	Scales & balances, exc. laboratory ...			●			●		
3579	Office machines, nec. (incl. typewriters)			●			●		
3581	Automatic merchandising machines .						●		
3582	Commercial laundry equipment						●		
3585	Refrigeration & heating equipment ..				●		●		
3586	Measuring & dispensing pumps						●		
3589	Service industry machines, nec.						●		
3592	Carburetors, pistons, rings, valves ...						●		
3599	Machinery, exc. electrical, nec.						●		
3612	Transformers								
3613	Switchgear & switchboard apparatus .			●			●		
3621	Motors & generators								
3622	Industrial controls			●			●		
3623	Welding apparatus, electric								
3624	Carbon & graphite products						●		
3629	Electric industrial apparatus, nec. ...			●			●		
3631	Household cooking equipment								
3632	Household refrigerators & freezers ..						●	●	

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature 700°F[b]	T/E ≤ 1[c]	Declining Production[d]	Fuel Supply[e]	E/V < 1%[f]	Other Studies[g]	No Information[h]
	CRITERIA FOR ELIMINATION								
3633	Household laundry equipment								
3634	Electrical housewares & fans						•		
3635	Household vacuum cleaners			•			•		
3636	Sewing machines						•		
3639	Household appliances, nec.								
3641	Electric lamps						•		
3643	Current carrying wiring devices			•			•		
3644	Noncurrent carrying wiring devices			•					
3645	Residential lighting fixtures			•					
3646	Commercial lighting fixtures								
3647	Vehicular lighting equipment								
3648	Lighting equipment, nec.			•					
3651	Radio & TV receiving sets			•			•		
3652	Phonograph records								
3661	Telephone & telegraph apparatus			•			•		
3662	Radio & TV communication equipment			•			•		
3671	Electron tubes, receiving type			•			•		
3672	Cathode ray television tubes			•					
3673	Electron tubes, transmitting			•			•		
3674	Semiconductors & related devices			•			•		
3675	Electronic capacitors			•					
3676	Electronic resistors			•					
3677	Electronic coils & transformers			•					
3678	Electronic connectors			•					
3679	Electronic components, nec.			•			•		
3691	Storage batteries								
3692	Primary batteries, dry & wet			•			•		
3693	X-ray apparatus & tubes			•			•		
3694	Engine electrical equipment								
3699	Electrical equipment & supplies, nec.			•			•		

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature 700°F[b]	T/E ≤ 1[c]	Declining Production[d]	Fuel Supply[e]	E/V ≤ 1%[f]	Other Studies[g]	No Information[h]
		CRITERIA FOR ELIMINATION							
3711	Motor vehicles & car bodies								
3713	Truck & bus bodies (incl. motor homes)								
3714	Motor vehicle parts & accessories						●		
3715	Truck trailers						●		
3721	Aircraft			●			●		
3724	Aircraft engines & engine parts			●			●		
3728	Aircraft equipment, nec.			●			●		
3731	Ship building & repair			●			●		
3732	Boat building & repairing						●		
3743	Railroad equipment				●		●		
3751	Motorcycles, bicycles & parts			●			●		
3761	Guided missiles & space vehicles			●	●		●		
3764	Space propulsion units & parts			●			●		
3769	Space vehicle equipment, nec.			●	●		●		
3792	Travel trailers & campers						●		
3795	Tanks & tank components						●		
3799	Transportation equipment, nec.			●			●		
3811	Engineering & scientific instruments						●		
3822	Environmental controls			●			●		
3823	Process control instruments			●			●		
3824	Fluid meters & counting devices			●			●		
3825	Instruments to measure electricity			●			●		
3829	Measuring & controlling devices, nec.			●			●		
3832	Optical instruments & lenses			●			●		
3841	Surgical & medical instruments			●			●		
3842	Surgical appliances & supplies						●		
3843	Dental equipment & supplies						●		
3851	Ophthalmic goods						●		
3861	Photographic equipment & supplies						●		
3873	Watches, clocks, & watchcases			●			●		

TABLE E.1 (cont)

SIC	Industry	No steam or HW[a]	Temperature 700°F[b]	T/E < 1[c]	Declining Production[d]	Fuel Supply[e]	E/V ≤ 1%[f]	Other Studies[g]	No Information[h]
		CRITERIA FOR ELIMINATION							
3911	Jewelry, precious metal						•		
3914	Silverware & plated ware				•		•		
3915	Jewelers' findings & lapidary work			•			•		
3931	Musical instruments & parts						•		
3942	Dolls			•			•		
3944	Games, toys, & children's vehicles						•		
3949	Sporting & athletic goods, nec.						•		
3951	Pens & mechanical pencils			•			•		
3952	Lead pencils & art goods						•		
3953	Marking devices			•			•		
3955	Carbon paper & inked ribbons						•		
3961	Costume jewelry			•			•		
3962	Artificial flowers						•		
3963	Buttons						•		
3964	Needles, pins, & fasteners			•			•		
3991	Brooms & brushes			•			•		
3993	Signs & advertising displays						•		
3995	Burial caskets						•		
3996	Hard surface floor coverings						•		
3999	Manufacturing industries, nec.						•		

NOTES TO TABLE E.1

[a]Elimination is based on the fact that the industry has either very minor or no use at all for process steam or hot water. Although the waste heat generated in a Brayton cycle dish cogeneration module is hot air, it is very uneconomical to transport this hot air directly to the point of use. The selected systems assume that the waste heat is used to produce steam or to heat a transport fluid at the point of generation. This fluid is then transported to the point of use and used directly or reconverted to the required form. Systems which reconvert this heat for heating air have been generally less successful than those producing steam or hot water, therefore we restrict ourselves to industries with such demand.

[b]Since the waste heat from a Brayton cycle module will be of the order of 1500°F, we assume that process heat needs can be satisfied only for some end-use temperature below 1500°F. In practice, temperature losses will naturally be encountered to facilitiate one or more heat exchanges. Furthermore, as transport temperatures go above 600°F, it becomes extremely costly to transport heat in a dish system. We select 700°F as the maximum process temperature demand which can be accommodated in a topping cycle dish cogeneration system.

[c]Elimination is based on thermal-to-electric demand ratios calculated in several studies and based either on average industry-wide energy purchase data (1974 and 1976) or upon selected site-specific surveys. Unfortunately, the actual T/E ratio at a specific plant may differen significantly from that of another plant in the same industry group. However, the eliminations shown reflect our best judgment regarding typical demand ratios in these industries. Very low T/E ratios (less than about 1.0) imply that no electric power could be exported to the grid and that a separate power-only system is very likely to be more cost-effective than a thermal cogeneration system. Very large T/E ratios also imply a mismatch between the dish cogeneration system capabilities and demand, but no industries are eliminated on this basis since a primary objective of this study is to analyze the effect of export power revenues on dish system values. (Solar Total Energy Systems Second Technical Progress Report, SAN-1101/PAZ-19, El Segundo, CA: The Aerospace Corp., 1 Dec. 1977, Table VI-9; Industrial Applications of Solar Total Energy: Volume 4 Catalog of First-Level Designs, SAN-1132-2/4, Huntington Beach, CA: McDonnell-Douglas Astronautics, April 1977; Krawiec, Frank, et al., Current and Future Industrial Energy Service Characterization, SERI/TR-733-790, Golden, CO: Solar Energy Research Institute, October 1980; Pacific Coast Paper Box Manufacturers Association, private communication, May 1980.)

[d]Elimination is based on forecasts of the compound annual rate of growth in industry shipments (constant dollars) as predicted by the Bureau of Economic Analysis, US Department of Commerce, and published in the 1980 US Industrial Outlook, pp. 499-503. Industries which had a forecast rate of growth of 1% or less for the period 1979-1984 were eliminated from consideration. The

average growth in real GNP over this same period was forecast to be 3%. (1980 US Industrial Outlook, Industry and Trade Administration, Washington, DC: US Department of Commerce, January 1980).

[e]Elimination is based on a judgment as to the likelihood of a given industry considering the swithc to coal as an immediate opportunity, the current use of or need for coal as a primary fuel, or the availability of a secure and large source of internally generated fuels for cogeneration. For instance, the necessity of using coal for chemical reduction as well as heat in the basic steel industry would make the consideration of dish cogeneration extremely unlikely in this industry. Likewise, the historic use of waste wood products in paper and pulp mills makes it unlikely that dish cogeneration would be considered a primary alternative for cogeneration in this industry.

[f]Elimination is based on data compiled in the 1980 US Industrial Outlook on energy costs as a per cent of the total value of shipments. Data are from the 1977 Census of Manufactures. The average cost of energy as a per cent of the value of shipments for manufacturing industries (SIC 20-39) was 2.4% in 1977; the average for nondurable manufacturing was 2.7% and the average for durable goods manufacturing was 2.2%. Industries are eliminated from consideration if they belong to a two-digit SIC group with energy costs which are 1.5% or less of the total value of shipments. Further elimination was based on information from Krawie, F., et al., SERI/TR-733-790 (op. cit.), Table 7 of Vol. 2. Industries using less than approximately 8,000 Btu of purchased fuels and electricity per dollar of value added were eliminated.

[g]Several studies have been made of solar applications to industry which have shown certain applications to be unsuitable for solar energy for reasons other than the specific criteria shown. Industries were identified for elimination based on the following studies: Wilson, Vickie, and Insights West. Solar Inudstrial Process Heat - A Study of Applications and Attitudes, SERI/TR-98348-1; Aerospace Corp. Field Survey of Solar High-Temperature Industrial Process Heat Applications. ATR-79(4820)-1; Brown, K. C., et al. End-Use Matching for Solar Industrial Process Heat. SERI/TR-34-091. Insights West. Solar-Augmented Applications in Industry. GRI-78/0036; Office of Solar Applications for Industry (DOE). Solar Industrial Market Strategy (DRAFT); unpublished information from SERI applications analyses.

[h]Where little or no information was avilable on technical or business factors (generally for minor industrial categories), the industry was eliminated from consideration in this study.

TABLE E.2 INDUSTRY-LEVEL PURCHASES OF FUEL AND ELECTRICITY FOR 75 U.S. INDUSTRIES

SIC	Industry	Thermal/ Electric Demand Ratio	1976 Total Purchased Fuel (10^{12} Btu)	1976 Total Purchased Electricity (10^{9} kWh)
2013	Sausage & other prepared meats	2.5	12.5	1.4
2016	Poultry dressing plants	2.4	12.5	1.5
2022	Cheese, natural & processed	6.5	19.4	0.9
2026	Fluid milk	1.5 (0.9-2.0)	28.9	3.0
2033	Canned fruits & vegetables	10.0 (7.0-18.0)	40.8	1.3
2035	Pickles, sauces, salad dressings	6.5	5.0	0.2
2037	Frozen fruits & vegetables	4.0	24.2	1.7
2044	Rice milling	2.9	2.6	0.3
2046	Wet corn milling	17.0	78.5	1.3
2047	Dog, cat, & other pet food	4.5	11.4	0.7
2051	Bread, cake, & related products	4.5	33.2	2.2
2065	Confectionery products	2.7	10.1	1.1
2066	Chocolate & cocoa products	3.0	3.4	0.3
2076	Vegetable oil mills, nec.	7.0	2.2	0.1
2077	Animal & marine fats & oils	11.0	21.7	0.6
2079	Shortening & cooking oils	11.0	23.7	0.6
2082	Malt beverages	5.0	39.8	2.0
2086	Bottled & canned soft drinks	3.5	16.3	1.3
2091	Canned & cured seafoods	5.0	2.6	0.1
2092	Fresh or frozen pkgd. fish	2.0 (2.0-5.0)	2.6	0.4
2095	Roasted coffee	5.0	8.8	0.5
2253	Knit outerwear mills	2.5	6.0	0.7
2254	Knit underwear mills	4.0	3.0	0.2
2257	Circular knit fabric mills	3.7	18.4	1.5
2258	Warp knit fabric mills	3.0	8.1	0.7

TABLE E.2 (cont)

SIC	Industry	Thermal/ Electric Demand Ratio	1976 Total Purchased Fuel (10^{12} Btu)	1976 Total Purchased Electricity (10^9 kWh)
2261	Finishing plants, cotton	15.0	24.2	0.5
2262	Finishing plants, synthetic	11.0	38.7	1.0
2272	Tufted carpets & rungs	7.0	22.9	0.9
2295	Coated fabric, not rubberized	5.0	8.3	0.4
2296	Tire cord & fabric	4.0	4.5	0.3
2436	Softwood veneer & plywood	3.0	25.1	2.3
2491	Wood preserving	14.0	7.4	0.1
2646	Pressed & molded pulp goods	2.5	5.7	0.6
2647	Sanitary paper products	2.0	6.6	0.8
2821	Plastics materials & resins	5.0	140.1	8.2
2822	Synthetic rubber	8.2	36.2	1.3
2823	Cellulosic man-made fibers	30.0	54.9	0.5
2824	Organic fibers, noncellulosic	4.5	109.3	6.7
2833	Medicinals & botanicals	8.8	21.9	0.7
2841	Soap & other detergents	8.0	22.3	0.8
2843	Surface active agents	8.0	9.1	0.3
2861	Gum & wood chemicals	13.0	7.9	0.2
2865	Cyclic crudes & intermediates	9.0	154.0	4.9
2869	Industrial organic chemicals, nec.	13.0	1,021.8	22.2
2873	Nitrogenous fertilizers	16.0	22.8	5.0
2874	Phosphatic fertilizers	5.0 (4.5-9.0)	55.7	3.3
2879	Agricultrual chemicals, nec.	6.5	23.6	1.0
2891	Adhesives & sealants	7.0	7.2	0.3
2892	Explosives	10.0	17.3	0.5
2911	Petroleum refining	12.5 (9.0-40.0)	1,128.2	26.3
2951	Paving mixtures & blocks	14.0	29.7	0.6
2952	Asphalt felts & coatings	13.0	26.7	0.6

TABLE E.2 (cont)

SIC	Industry	Thermal/ Electric Demand Ratio	1976 Total Purchased Fuel (10^{12} Btu)	1976 Total Purchased Electricity (10^9 kWh)
2992	Lubricating oils & greases	9.5	5.9	0.2
3269	Pottery products, nec.	12.0	4.9	0.1
3271	Concrete block & brick	8.0 (5.0-20.0)	15.9	0.4
3272	Concrete products, nec.	8.5	18.3	0.6
3317	Steel pipe & tubes	4.0	9.9	0.7
3411	Metal cans	3.0	25.1	1.8
3431	Metal sanitary ware	6.0	5.0	0.2
3444	Sheet metalwork	3.0	9.2	0.8
3471	Plating & polishing	3.3	16.4	1.4
3493	Steel springs exc. wire	7.0	4.3	0.2
3495	Wire springs	3.0	2.1	0.2
3612	Transformers	2.4	5.7	0.7
3621	Motors & generators	2.7	11.5	1.2
3623	Welding apparatus, electric	2.7	2.2	0.2
3631	Household cooking equipment	4.0	5.8	0.4
3633	Household laundry equipment	3.5	6.1	0.5
3639	Household applicances, nec.	6.0	4.6	0.2
3646	Commercial lighting fixtures	3.0	2.6	0.2
3647	Vehicular lighting equipment	2.8	3.2	0.3
3652	Phonograph records	3.0	3.1	0.3
3711	Motor vehicles & car bodies	3.5	94.9	7.1
3713	Truck & bus bodies (incl. motor)	3.5	4.4	0.3
TOTAL	75 Industries		3,728.9	132.9

APPENDIX F

Appendix C presented detailed results of the simulated energy displacement allocations for each PDS system size in both states for the industries studied. The tables in this appendix document the operations performed on those results in the process of developing the allowable installed costs of Table 3.7. The tables are explained as follows:

> Table F.1 collects the results of the three seasonal runs for each system size (see Appendix C) in each state, and presents the results of a first-year analysis with all results for a single industry shown together. Note that the "Total" column in each case displays the result 90(Winter) + 183(Spring/Fall) + 92 (Summer). This adjustment is necessary to correct for the different number of days in each season in converting from daily to yearly energy displacement.
>
> Table F.2 is included only to show the effects of system size on first-year savings. It is not used as a basis for further calculations.
>
> Table F.3 repeats the same present value and breakeven cost factors used for the analytical approach of Section 2. They are also used in this approach to facilitate comparison.
>
> Tables F.4 and F.5 show the totals of escalated fuel savings, discounted at three different discount rates. The fuel-specific present value factors of Table F.3 were applied to their respective fuels and the results summed, to produce the present value totals.

The 20-year present values of Tables F.4 and F.5 are specific to system size, industry, discount rate, and state (where state determines insolation conditions and prices of conventional energy). When each of these present values is divided first by the appropriate value of $[(FCR/CRF) + 0.02\ G_{om}]$, then by the size of the system in m^2, the result is the corresponding allowable installed system cost of Table 3.7.

TABLE F.1 FIRST-YEAR SAVINGS IN TOTAL $ BY FUEL TYPE FOR FIVE INDUSTRIES UNDER ARIZONA CONDITIONS AND CALIFORNIA CONDITIONS

PDS System Sizes	Metal Coating SIC 3479	Arizona Winter	Arizona Spring/Fall	Arizona Summer	Arizona Total	California Winter	California Spring/Fall	California Summer	California Total
200 m^2	Thermal	3.68	3.89	5.14	1515.95	4.14	4.37	5.78	1704.07
	Disp. Elec.	11.79	12.67	16.65	4911.51	13.19	14.17	18.63	5494.17
	Export Elec.	0	0	0	0	0	0	0	0
				Total Value	6427.46				7198.24
1000 m^2	Thermal	15.32	17.59	21.60	6584.97	19.35	21.67	27.38	8226.07
	Disp. Elec.	57.62	63.31	81.74	24291.61	65.95	70.87	93.13	27472.67
	Export Elec.	0.99	0	1.13	193.06	0	0	0	0
				Total Value	31069.64				35698.74
2500 m^2	Thermal	17.46	20.14	23.93	7458.58	22.92	26.35	31.36	9769.97
	Disp. Elec.	68.61	79.11	94.63	29357.99	88.86	102.70	124.00	38199.50
	Export Elec.	57.81	58.18	83.29	23512.52	87.42	85.68	125.10	35056.44
				Total Value	60329.09				83025.91
5000 m^2	Thermal	17.61	21.14	24.66	7722.24	23.51	27.94	32.92	10257.56
	Disp. Elec.	72.27	84.32	100.10	31144.06	95.98	111.00	131.70	41067.60
	Export Elec.	163.30	170.60	232.00	67260.80	268.80	279.90	384.00	110741.70
				Total Value	106127.10				162066.86
25000 m^2	Thermal	17.61	21.66	24.66	7722.24	23.51	28.21	32.92	10306.97
	Disp. Elec.	72.27	86.72	101.20	31685.46	95.98	115.20	134.40	42084.60
	Export Elec.	1028.00	1098.00	1453.00	427130.00	1786.00	1095.00	252.30	532566.00
				Total Value	466536.70				584958.17

TABLE F.1 FIRST-YEAR SAVINGS IN TOTAL $ BY FUEL TYPE FOR FIVE INDUSTRIES UNDER ARIZONA CONDITIONS AND CALIFORNIA CONDITIONS (cont)

PDS System Sizes	Fluid Milk SIC 2026	ARIZONA Winter	ARIZONA Spring/Fall	ARIZONA Summer	ARIZONA Total	CALIFORNIA Winter	CALIFORNIA Spring/Fall	CALIFORNIA Summer	CALIFORNIA Total
200 m^2	Thermal	3.68	3.89	5.14	1515.95	4.14	4.37	5.78	1704.07
	Disp. Elec.	11.79	12.67	16.65	4911.51	13.19	14.17	18.63	5494.17
	Export Elec.	0	0	0	0	0	0	0	0
				Total Value	6427.46				7198.24
2500 m^2	Thermal	41.12	46.65	57.98	17571.91	50.79	54.58	71.45	21132.64
	Disp. Elec.	109.20	125.40	153.60	46907.40	140.40	158.60	197.70	59848.20
	Export Elec.	28.01	24.23	40.06	10640.51	28.21	21.39	40.36	10166.39
				Total Value	75119.82				91147.23
5000 m^2	Thermal	46.09	53.51	63.75	19805.43	59.98	70.12	83.91	25949.88
	Disp. Elec.	120.30	137.50	164.40	51114.30	155.70	179.80	215.00	66696.40
	Export Elec.	128.00	131.50	184.80	52586.10	200.10	200.80	288.20	81269.80
				Total Value	123505.83				173916.08
15000 m^2	Thermal	48.46	58.16	67.85	21246.88	64.69	77.38	90.56	28314.16
	Disp. Elec.	123.80	148.60	173.40	54288.60	164.50	197.10	230.20	72052.70
	Export Elec.	558.00	588.20	789.00	230448.60	948.50	995.80	1342.00	391060.40
				Total Value	305984.08				491427.26
25000 m^2	Thermal	48.46	58.16	67.85	21246.88	64.69	77.63	90.56	28359.91
	Disp. Elec.	123.80	148.60	173.40	54288.60	164.50	197.30	230.20	72089.30
	Export Elec.	990.60	1053.00	1400.00	410653.00	1707.00	1810.00	2412.00	706764.00
				Total Value	486188.48				807213.21

TABLE F.1 FIRST-YEAR SAVINGS IN TOTAL $ BY FUEL TYPE FOR FIVE INDUSTRIES UNDER ARIZONA CONDITIONS AND CALIFORNIA CONDITIONS (Cont)

PDS System Sizes	Motor Vehicles SIC 3711	ARIZONA Winter	ARIZONA Spring/Fall	ARIZONA Summer	ARIZONA Total	CALIFORNIA Winter	CALIFORNIA Spring/Fall	CALIFORNIA Summer	CALIFORNIA Total
200 m^2	Thermal	3.68	3.89	5.14	1515.95	4.14	4.37	5.78	1704.07
	Disp. Elec.	11.79	12.67	16.65	4911.51	13.19	14.17	18.63	5494.17
	Export Elec.	0	0	0	0	0	0	0	0
				Total Value	6427.46				7198.24
25000 m^2	Thermal	460.20	485.60	642.70	189411.20	517.30	545.80	722.40	212899.20
	Disp. Elec.	1474.00	1584.00	2082.00	614076.00	1649.00	1772.00	2328.00	686862.00
	Export Elec.	0	0	0	0	0	0	0	0
				Total Value	803487.20				899761.20
50000 m^2	Thermal	920.40	971.20	1285.00	378785.60	1035.00	1092.00	1445.00	425926.00
	Disp. Elec.	2105.00	2417.00	2946.00	902793.00	2701.00	3066.00	3813.00	1154964.00
	Export Elec.	618.60	551.40	892.90	238727.00	685.70	549.30	969.70	251447.30
				Total Value	1520305.60				1832337.30
100000 m^2	Thermal	1755.00	1939.00	2478.00	740763.00	2069.00	2183.00	2889.00	851487.00
	Disp. Elec.	2304.00	2637.00	3152.00	979915.00	2994.00	3444.00	4119.00	1278660.00
	Export Elec.	2636.00	2714.00	3796.00	1083134.00	4142.00	4189.00	5972.00	1688791.00
				Total Value	2803812.00				3818938.00

TABLE F.1 FIRST-YEAR SAVINGS IN TOTAL $ BY FUEL TYPE FOR FIVE INDUSTRIES UNDER ARIZONA CONDITIONS AND CALIFORNIA CONDITIONS (cont)

PDS System Sizes	Bread, Cake SIC 2051	ARIZONA Winter	ARIZONA Spring/Fall	ARIZONA Summer	ARIZONA Total	CALIFORNIA Winter	CALIFORNIA Spring/Fall	CALIFORNIA Summer	CALIFORNIA Total
200 m^2	Thermal	3.68	3.89	5.14	1515.95	4.14	4.37	5.78	1704.07
	Disp. Elec.	11.79	12.67	16.65	4911.51	13.19	14.17	18.63	5494.17
	Export Elec.	0	0	0	0	0	0	0	0
				Total Value	6427.46				7198.24
1000 m^2	Thermal	18.41	19.42	25.71	7576.08	20.69	21.83	28.89	8514.87
	Disp. Elec.	44.55	51.07	62.77	19130.15	57.27	64.56	80.55	24406.38
	Export Elec.	10.58	9.02	15.04	3986.54	9.98	7.25	14.47	3556.19
				Total Value	30692.77				36477.44
2500 m^2	Thermal	45.75	48.56	64.12	18903.02	51.73	54.58	72.24	21289.92
	Disp. Elec.	50.11	57.60	68.81	21381.22	65.62	75.06	89.72	27896.02
	Export Elec.	71.39	73.96	102.20	29362.18	114.10	117.40	164.50	46887.20
				Total Value	69646.42				96073.14
5000 m^2	Thermal	55.04	64.27	77.17	23814.65	71.92	83.55	100.90	31045.25
	Disp. Elec.	50.75	60.65	71.05	22203.05	67.40	79.53	94.36	29301.11
	Export Elec.	179.10	187.90	253.30	78808.30	301.70	316.00	426.90	124255.80
				Total Value	119826.00				184602.16
15000 m^2	Thermal	59.65	71.15	83.51	26071.87	79.62	93.80	110.80	34524.80
	Disp. Elec.	50.75	60.90	71.05	22248.80	67.40	80.88	94.36	29548.16
	Export Elec.	611.60	652.60	864.10	253967.00	1060.00	1129.00	1498.00	439823.00
				Total Value	302287.67				503895.96

TABLE F.1 FIRST-YEAR SAVINGS IN TOTAL $ BY FUEL TYPE FOR FIVE INDUSTRIES UNDER ARIZONA CONDITIONS AND CALIFORNIA CONDITIONS (cont)

PDS System Sizes	Bread, Cake SIC 2051 (cont)	Winter	Spring/ Fall	Summer	Total	Winter	Spring/ Fall	Summer	Total
25000 m^2	Thermal	59.65	71.58	83.51	26150.56	79.62	95.54	111.50	34907.62
	Disp. Elec.	50.75	60.90	71.05	22248.80	67.40	80.88	94.36	29548.16
	Export Elec.	1044.00	1117.00	1475.00	434071.00	1818.00	194[illegible].00	2569.00	755720.00
				Total Value	482470.36				820175.78

TABLE F.1 FIRST-YEAR SAVINGS IN TOTAL $ BY FUEL TYPE FOR FIVE INDUSTRIES UNDER ARIZONA CONDITIONS AND CALIFORNIA CONDITIONS (cont)

PDS System Sizes	Industrial Organic Chemicals SIC 2869	Winter	Spring/ Fall	Summer	Total	Winter	Spring/ Fall	Summer	Total
200 m^2	Thermal	3.68	3.89	5.14	1515.95	4.14	4.37	5.78	1704.07
	Disp. Elec.	11.79	12.67	16.65	4911.51	13.19	14.17	18.63	5494.17
	Export Elec.	0	0	0	0	0	0	0	0
				Total Value	6427.46				7198.24
5000 m^2	Thermal	92.04	97.12	128.50	37878.56	103.50	109.20	144.50	42592.60
	Disp. Elec.	294.90	316.90	416.40	122842.50	329.80	354.40	465.70	137381.60
	Export Elec.	0	0	0	0	0	0	0	0
				Total Value	160721.06				179974.20
10000 m^2	Thermal	184.10	194.20	257.10	75760.80	206.90	218.30	288.90	85148.70
	Disp. Elec.	530.80	597.10	747.80	225838.90	655.70	708.70	928.70	274145.50
	Export Elec.	43.21	26.86	62.27	14533.12	4.46	0	2.98	675.56
				Total Value	316132.82				359969.76
15000 m^2	Thermal	276.10	291.40	385.60	113650.40	310.40	327.50	433.40	127741.30
	Disp. Elec.	571.50	657.40	800.80	245412.80	740.20	849.60	1042.00	317958.80
	Export Elec.	229.70	215.00	328.80	90267.60	286.40	245.50	408.50	108284.50
				Total Value	449330.80				553984.60
25000 m^2	Thermal	460.20	485.60	642.70	189411.20	517.30	545.80	722.40	212899.20
	Disp. Elec.	614.40	701.80	839.10	260922.60	793.70	917.70	1098.00	340388.10
	Export Elec.	630.80	647.30	911.50	259085.90	983.30	982.10	1415.00	398401.30
				Total Value	709419.70				951688.60

TABLE F.2 FIRST YEAR FUEL SAVINGS IN $ PER m^2 FOR VARIOUS PDS SYSTEM SIZES

Industry / PDS System Sizes Evaluated	ARIZONA Winter	ARIZONA Spring/Fall	ARIZONA Summer	ARIZONA Total	CALIFORNIA Winter	CALIFORNIA Spring/Fall	CALIFORNIA Summer	CALIFORNIA Total
Metal Coating SIC 3479								
200 m^2	6.96	15.15	10.03	32.14	7.80	16.96	11.23	35.99
1000 m^2	6.65	14.81	9.61	31.07	7.68	16.93	11.09	35.70
2500 m^2	5.18	11.52	7.43	24.13	7.17	15.72	10.32	33.21
5000 m^2	4.56	10.10	6.56	21.22	6.99	15.33	10.09	32.41
25000 m^2	4.03	8.83	5.81	18.67	6.86	14.99	9.90	31.75
Fluid Milk SIC 2026								
200 m^2	6.96	15.15	10.03	32.14	7.80	16.96	11.23	35.99
2500 m^2	6.42	14.37	9.26	30.05	7.90	17.17	11.39	36.46
5000 m^2	5.30	11.81	7.60	24.71	7.48	16.49	10.80	34.77
15000 m^2	4.38	9.70	6.32	20.40	7.07	15.50	10.20	32.77
25000 m^2	4.19	9.22	6.04	19.45	6.97	15.26	10.06	32.29
Motor Vehicles and Auto Bodies SIC 3711								
200 m^2	6.96	15.15	10.03	32.14	7.80	16.96	11.23	35.99
25000 m^2	6.96	15.15	10.03	32.14	7.80	16.96	11.23	35.99
50000 m^2	6.56	14.42	9.43	30.41	7.96	17.23	11.46	36.65
100000 m^2	6.03	13.34	8.67	28.04	8.28	17.96	11.94	38.18

TABLE F.2 FIRST YEAR FUEL SAVINGS IN $ PER m^2 FOR VARIOUS PDS SYSTEM SIZES (cont)

Industry / PDS System Sizes Evaluated	ARIZONA Winter	ARIZONA Spring/Fall	ARIZONA Summer	ARIZONA Total	CALIFORNIA Winter	CALIFORNIA Spring/Fall	CALIFORNIA Summer	CALIFORNIA Total
Bread, Cake SIC 2051								
200 m^2	6.96	15.15	10.03	32.14	7.80	16.96	11.23	35.99
1000 m^2	6.62	14.55	9.52	30.69	7.92	17.14	11.40	36.46
2500 m^2	6.02	13.18	8.65	27.85	8.33	18.09	12.02	38.44
5000 m^2	5.13	11.45	7.39	23.97	7.94	17.53	11.45	36.92
15000 m^2	4.33	9.57	6.25	20.15	7.24	15.91	10.45	33.60
25000 m^2	4.16	9.15	6.00	19.31	7.08	15.52	10.21	32.81
Industrial Organic Chemicals SIC 2869								
200 m^2	6.96	15.15	10.03	32.14	7.80	16.96	11.23	35.99
5000 m^2	6.96	15.15	10.03	32.14	7.80	16.96	11.23	35.99
10000 m^2	6.82	14.97	9.82	31.61	7.80	16.96	11.23	35.99
15000 m^2	6.46	14.20	9.29	29.95	8.02	17.36	11.55	36.93
25000 m^2	6.14	13.43	8.81	28.38	8.26	17.90	11.90	38.06

TABLE F.3 PRESENT VALUE FACTORS AND COMPONENTS OF LIFE-CYCLE BREAKEVEN CONDITION FOR SELECTED DISCOUNT RATES

Discount Rates	R = 0.150	R = 0.020	R = 0.250
Present Value Factors			
Thermal Fuels[a]	30.694	20.229	14.319
Electricity (both displaced and exported) (G_e)	15.329	10.477	7.657
Operations and Maintenance (G_{om})	12.957	9.070	6.764
Components of Breakeven Condition			
Fixed Charge Rate (FCR)	0.18094	0.24275	0.31120
Capital Recovery Factor (CRF)	0.15976	0.20536	0.25292
(FCR/CRF) + 0.002 G_{om}	1.392	1.363	1.366

[a] First-year thermal fuel savings were all computed in terms of 1979 prices. To convert those to estimates of prices as of 1985, quoted in 1980$, the adjustment factor $(1.074)^6$ from Section 2.3.1 was applied. Thus, the present value factor for thermal fuels equals, in each case, the respective G factor times $(1.074)^6 = 1.5347$.

TABLE F.4 FIRST-YEAR AND SELECTED PRESENT VALUES OF FUEL SAVINGS BY FUEL TYPE FOR ARIZONA CONDITIONS

Industry	PDS System Sizes Evaluated	First-Year Savings: Thermal Fuel	First-Year Savings: Displaced Electricity	First-Year Savings: Exported Electricity	Total First-Year Savings	Twenty-Year Present Values of Escalated Total First-Year Savings: 15%	20%	25%
Metal Coating SIC 3479	200 m^2	1516	4912	0	6427	121828	82130	59319
	1000 m^2	6585	24292	193	31070	577451	389737	281772
	2500 m^2	7459	29358	23513	60329	1039406	704818	511639
	5000 m^2	7722	31144	67261	106127	1745469	1187198	864058
	25000 m^2	7722	31684	427130	466537	7270179	4963203	3623710
Fluid Milk SIC 2026	200 m^2	1516	4912	0	6427	121828	82130	59319
	2500 m^2	17572	46907	10641	75120	1421508	958394	692259
	5000 m^2	19805	51114	52586	123506	2197512	1487100	1077619
	15000 m^2	21247	54289	230449	305984	5016904	3413006	2484475
	25000 m^2	21247	54289	410653	486188	7779251	5301003	3864297
Motor Vehicles SIC 3711	200 m^2	1516	4192	0	6427	121828	82130	59319
	25000 m^2	189411	614076	0	803487	15226952	10265269	7414156
	50000 m^2	378786	902793	238727	1520306	29124818	19622167	14164455
	100000 m^2	740763	979915	1083134	2803812	54361458	36599459	26403752
Bread, Cake SIC 2051	200 m^2	1516	4912	0	6427	121828	82130	59319
	1000 m^2	7576	19130	3987	30693	586898	395452	285488
	2500 m^2	18903	21381	29362	69646	1358048	914023	659211
	5000 m^2	23815	22203	78808	119826	2279375	1540046	1114448
	15000 m^2	26072	22249	253967	302288	5034369	3421326	2488311
	25000 m^2	26152	22249	434071	482470	7797639	5309893	3868513

TABLE F.4 FIRST-YEAR AND SELECTED PRESENT VALUES OF FUEL SAVINGS BY FUEL TYPE FOR ARIZONA CONDITIONS (cont)

Industry	PDS System Sizes Evaluated	Fist-Year Savings			Total First-Year Savings	Twenty-Year Present Values of Escalated Total First-Year Savings		
		Thermal Fuel	Displaced Electricity	Exported Electricity		15%	20%	25%
Industrial Organic Chemicals SIC 2869	200 m^2	1516	4912	0	6427	121828	82130	59319
	5000 m^2	37879	122843	0	160721	3045718	2053280	1482998
	10000 m^2	75761	225839	14533	316133	6010071	4050947	2925350
	15000 m^2	113650	245143	90268	449331	8629888	5813127	4195596
	25000 m^2	189411	260923	259086	709420	13784999	9279729	6693885

TABLE F.5 FIRST-YEAR AND SELECTED PRESENT VALUES OF FUEL SAVINGS BY FUEL TYPE FOR CALIFORNIA CONDITIONS

Industry	PDS System Sizes Evaluated	First-Year Savings: Thermal Fuel	First-Year Savings: Displaced Electricity	First-Year Savings: Exported Electricity	Total First-Year Savings	Twenty-Year Present Values of Escalated Total First-Year Savings: 15%	20%	25%
Metal Coating SIC 3479	200 m^2	1704	5494	0	7198	136520	92031	66467
	1000 m^2	8226	27473	0	35699	673622	454238	328149
	2500 m^2	9770	38200	35056	83026	1422822	965140	700818
	5000 m^2	10258	41068	110742	162067	2641955	1798022	1309293
	25000 m^2	10307	42085	532566	584958	9125188	6229119	4547689
Fluid Milk SIC 2026	200 m^2	1704	5494	0	7198	136520	92031	66467
	2500 m^2	21133	59848	10166	91147	1721901	1161036	838701
	5000 m^2	25950	66696	81270	173916	3064680	2075182	1504554
	15000 m^2	28314	72053	391060	491427	7968129	5424799	3951484
	25000 m^2	28360	72089	706764	807213	12809519	8733737	6369764
Motor Vehicles SIC 3711	200 m^2	1704	5494	0	7198	136520	92031	56467
	25000 m^2	212899	686862	0	899761	17063630	11502987	8307803
	50000 m^2	425926	1154964	251447	1832337	34632247	23351025	16867723
	100000 m^2	851487	1278660	1688791	3818938	71623598	48314715	34914215
Bread, Cake SIC 2051	200 m^2	1704	5494	0	7198	136520	92031	66467
	1000 m^2	8515	24406	3556	36477	689989	465208	336031
	2500 m^2	21290	27896	46887	96073	1799824	1214177	877465
	5000 m^2	31045	29301	124256	184602	3306770	2236826	1620319
	15000 m^2	34525	29548	439823	503896	8254698	5616006	4088337
	25000 m^2	34908	29548	755720	820175	13108839	8933407	6512645

TABLE F.5 FIRST-YEAR AND SELECTED PRESENT VALUES OF FUEL SAVINGS BY FUEL TYPE FOR CALIFORNIA CONDITIONS (cont)

Industry	PDS System Sizes Evaluated	First-Year Savings			Total First-Year Savings	Twenty-Year Present Values of Escalated Total First-Year Savings		
		Thermal Fuel	Displaced Electricity	Exported Electricity		15%	20%	25%
Industrial Organic Chemicals SIC 2869	200 m^2	1704	5494	0	7198	136520	92031	66467
	5000 m^2	42593	137382	0	179974	3413278	2300965	1661823
	10000 m^2	85149	274146	676	359970	6826310	4601789	3323561
	15000 m^2	127741	317959	108285	553985	10454777	7049831	5092874
	25000 m^2	212899	340388	398401	951688	17552678	11844736	8562218

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